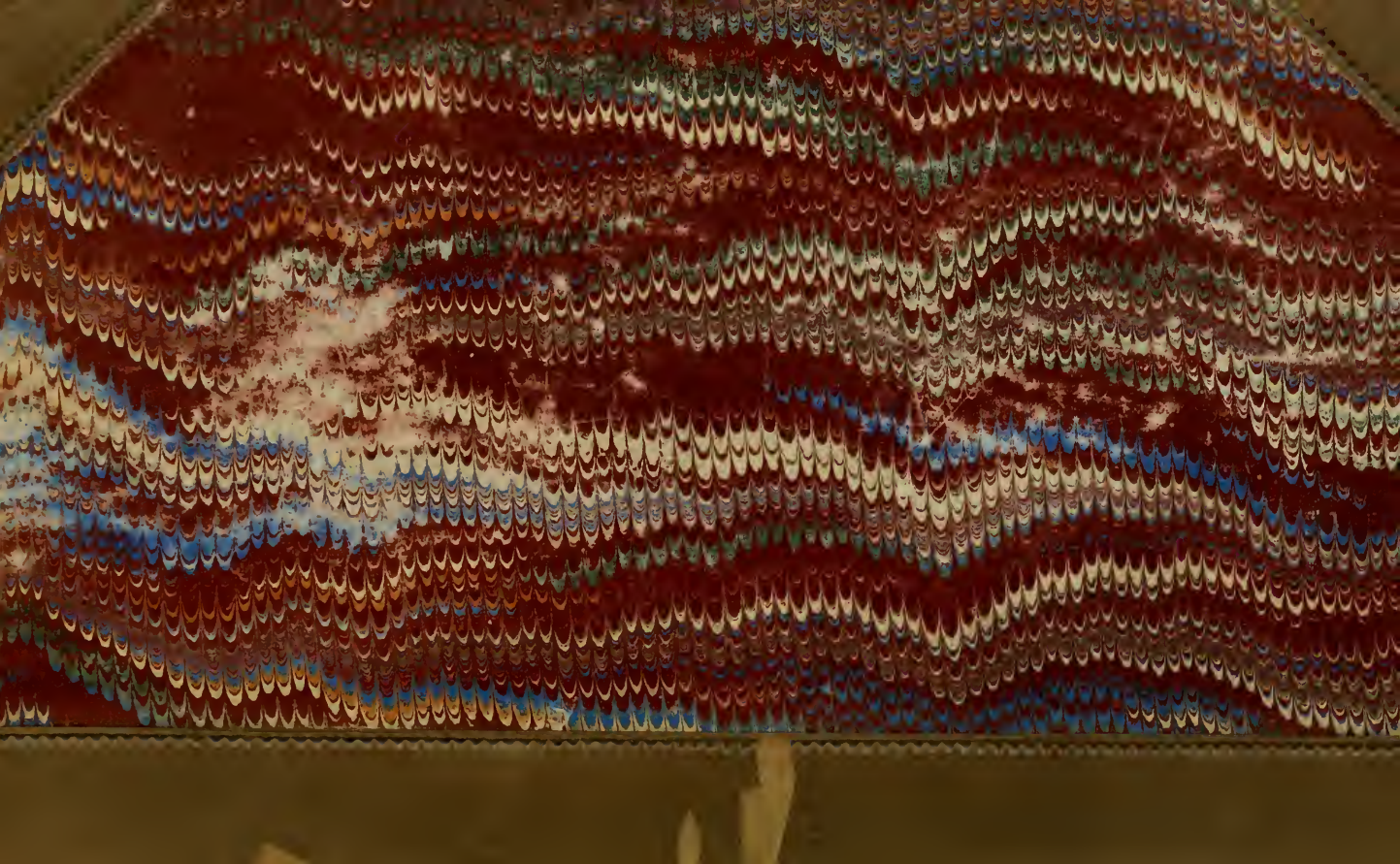

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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

VOL. IV.

LONDON:

PRINTED BY J. DAVIS, CHANCERY-LANE,

For ALEXANDER TILLOCH; and ſold by Meſſrs. RICHARDSON, Cornhill; CADELL and DAVIES, Strand; DEBRETT, Piccadilly; MURRAY and HIGHLEY, No. 32, Fleet-ſtreet; SYMONDS, Paternoſter-Row; BELL, No. 148, Oxford-ſtreet; VERNOR and HOOD, Poultry; HARDING, No. 36, St. James's-ſtreet; WESTLEY, No. 159, Strand; J. REMNANT, High-ſtreet, Bloomſbury; and W. REMNANT, Hamburgh.

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THE

PHILOSOPHICAL MAGAZINE.

JUNE 1799.

I. *On the Poſſibility of Caſual Mutilations in the Bodies of Animals becoming in the Courſe of Time hereditary Marks of Diſtinction. By Profeſſor* BLUMENBACH *.

THAT it is poſſible for mutilations produced in the bodies of animals, either by accident or by artificial means, eſpecially when repeated through a whole ſeries of generations, to degenerate in the courſe of time into hereditary marks of diſtinction, ſeems *à priori* to be incontrovertible. At any rate, I ſhould be glad to ſee the phyſiologiſt who can aſſign a reaſon why this ſhould not be as poſſible as the tranſmiſſion of hereditary organic diſeaſes, or hereditary monſtroſities †, or

* From *Magazin fur das Neueſte aus der Phyſik.* Vol. VI.

† Of the numerous and partly well known inſtances of this kind I ſhall quote only a recent one, mentioned by M. Schulz in his *Obſervations on a monſtrous canary bird*, p. 17. "A Spaniſh bitch," ſays he, "which had been in my poſſeſſion for ſeveral years, was not only brought forth without a tail, but at various times produced puppies ſome of whom were deſtitute of tails alſo. As often as this bitch brought forth more than one puppy, one of them perhaps was quite perfect; the greater part, however, had half tails or tails ſtill ſhorter, and one at leaſt had no tail at all. The moſt ſingular thing was, that the young almoſt always had a reſemblance

or the moſt individual traits in family likeneſſes, ſuch as a thick under lip, ſtrong eye-brows, and ſo on, which certainly did not all deſcend from Adam; but which have firſt appeared at a certain generation, and ſince that period have been continued, with more or leſs conſtancy, by hereditary tranſmiſſion.

I. *Inſtances among Animals.*

We are told by Sir Kenelm Digby*, that the tail of a cat having been cut off when young, ſome of the kittens, which ſhe afterwards brought forth, were always without tails. Nath. Highmore †, who in explaining the nature of generation differs ſo much from Sir Kenelm, ſays that he ſaw a bitch which wanted almoſt the whole tail from the rump, and that the half of her young were brought into the world with tails, and the other half without. Buffon ‡ aſſerts that he ſaw dogs, the ears and tails of which had been cropped for many generations, and which transferred this mutilation, either totally or in part, to their poſterity.

M. R. Maſch, of New Strelitz, gives an account, in the *Naturforſcher* §, of a butcher's dog, the tail of which, according to cuſtom, had been cut off, and which having copulated with a ſhe-wolf, that had been caught, the latter produced three baſtards. Among theſe was a male, half grey like the father, and born with a cropped tail; ſo that the caſual mutilation of the dog, as the author ſays, was tranſferred to this baſtard.

We are told by D. Forſter ‖, that it has been remarked in

to the father, whether grey-hound, ſpaniel, &c. in regard to colour and bodily conformation; and derived nothing more from their mother, the Spaniſh bitch, than the ſingularity of having only the third part of a tail, or no tail at all."

* On the Nature of Bodies, p. 214.

† Hiſtory of Generation, p. 31.

‡ Hiſtoire Naturelle, vol. xiv.

§ Part xv.

‖ Beyträge zur Volker-und Lander-Kunde, Part 1.

England,

England, that when horſes are continually docked, and both ſtallions and mares kept ſo for many generations, the foals, at laſt, come into the world with ſome articulations fewer in the tail. Buffon * has enlarged pretty fully on this ſubject, and endeavoured to prove, by the help of anatomy, that the calloſities on the breaſt-bone and knees of the camel are merely the conſequence of their ſubjection, and the force by which theſe animals of burden, as is well known, are obliged to kneel down; and as the young camels, when brought forth, have calloſities of the like kind, he gives this as a proof of the hereditary tranſmiſſion of ſuch variations produced by art.

II. *Inſtances among the Human Species.*

Cardan † ſpeaks of the well known ancient cuſtom of the Peruvians of *Puerto Viego*, who preſſed between boards the heads of their new-born children. This cuſtom, however, became afterwards like a ſecond nature; ſo that, in the courſe of time, children were brought into the world with heads formed in that ſingular manner: and Cardan expreſsly ſays, that this flatneſs of the head was originally the work of art, and not of nature. *Conſtat igitur*, to uſe his own expreſſions, *humanam formam multis modis variari, tum arte, tum diuturna ſucceſſione*. Hippocrates, in his work upon air, water and climate, mentions ſomething of the like kind in regard to the *Macrocephali*, a people on the borders of the Black Sea, who preſſed the heads of their new-born children; and this practice repeated, through many generations, produced at length an hereditary diſtinction; ſo that the children were born with heads of a particular form. "At firſt," ſays he ‡, "the practice of the country ſeems to have been the cauſe of this conformation; but cuſtom afterwards be-

* Hiſtoire Naturelle, vol. xi.

† Vol. iii. p. 162 of Spon's edition of his works.

‡ This paſſage is tranſlated from the original in Chartieri's edition, vol. vi. p. 206.

came nature. Thoſe who had the largeſt heads were conſidered as the nobleſt; and for this reaſon the *Macrocephali* preſſed the yet pliable tender heads of their children with their hands, and forced them to extend in length by bandages and other means. This artificial proceſs gave occaſion to the ſubſequent increaſe of ſize in the head among theſe people, ſo that artificial means were no longer requiſite for that purpoſe." Hippocrates, however, adds in a ſhort ſection: "That in his time their heads had no longer that ſingular form completely, becauſe they had entirely neglected the above artificial means of formation." But that this very little contradicts his preceding account and opinion is ſhewn by the intermediate paſſages, where he endeavours to explain the phenomenon from his well known theory of generation. "The generative matter," ſays he, "is collected from all parts of the body. From ſound bodies it comes ſound, and from diſeaſed bodies diſeaſed. Now, as bald heads, blue eyes, and overgrown bodies are tranſmitted in families, and the like rule takes place in other circumſtances of conformation, why ſhould not children with great heads be produced by great headed parents?" Hippocrates, therefore, evidently meant only that in the courſe of time Nature ſometimes abandons forms ſhe has aſſumed, and returns again to the original.

Ariſtotle, in his work on the generation of animals, ſpeaking of the grounds on which the theory of Hippocrates reſpecting generation is founded, ſays: "It is very probable for this reaſon, beſides others, that children not only reſemble their parents in internal and innate properties, but even in external marks which are merely caſual; for there are inſtances of moles being tranſmitted from parents to their children, and on the very ſame parts of the body. He himſelf quotes a Chaldean, who, having a mole on his arm, tranſmitted it to his ſon, though in the latter it was not ſo apparent as in the father. Pliny alſo, where he treats of marks, moles, and the like, being ſometimes inherited by children, adds,

adds, by way of example: *Quarto partu Dacorum originis nota in brachio redditur.* In my opinion, this paſſage alludes to the hereditary tranſmiſſion of moles among the Dacians, Illyrians, &c. who, according to the teſtimony of many of the Ancients, were diſtinguiſhed by this ſingularity.

The late M. Oſann once came to me, full of aſtoniſhment, and told me that he had met with a ſimilar inſtance in the family of a ſtaff-officer, who lived in the neighbourhood. The father in his younger days had received a wound in the little finger of his right hand, which had been rendered crooked during the cure; and his ſon and daughter were born each with the little finger of the ſame hand crooked. I have ſince ſeen both the father and daughter, and have been convinced, by inſpecting their hands, of the truth of the above information.

A literary man of very great acuteneſs, when converſing with me on this ſubject, ſtarted the following objection: "If artificial mutilations can become hereditary, children born of circumciſed parents muſt often be born without the foreſkin, which does not appear to be the caſe." At that time I was acquainted with only one inſtance of this kind in Steph. Gerlach's Journal; but one example did not appear to me to be of any peculiar weight. I, however, once happened to aſk a Jew of this place, a man not deſtitute of learning, and well acquainted with the ritual of his nation reſpecting this circumſtance, and was told that it frequently happened that the children of the Jews were brought into the world with ſo ſhort a foreſkin that it required an experienced and careful hand to circumciſe them. This innate deficiency is diſtinguiſhed by a particular Hebrew appellation, *nauld mohl*, or born circumciſed. His own father, who had circumciſed above 700 boys, and who was celebrated on account of his expertneſs in this caſe, not at all uncommon, often ſpoke of the difficulty of performing the operation under ſuch circumſtances. In a word, what had appeared to me an argument againſt the hereditary tranſmiſ-

ſion of artificial mutilations, became unexpectedly an important argument in its favour. I will, however, readily acknowledge, that all the caſes above mentioned may not be of equal authenticity, and equally incontrovertible; but even though the leaſt improbable ſhould be rejected, there will ſtill remain, to ſupport the probability of the thing, as many as could be deſired for a propoſition which cannot well be proved by direct experiments made for the purpoſe.

II. *Report on the Travels of* C. Olivier *and* C. Bruguiere, *undertaken by order of the French Government, through the Ottoman Empire, Egypt and Perſia, during the Years* 1792, 93, 94, 95, 96 *and* 97 *.

[Concluded from the laſt Volume, p. 347.]

THIS journey was extremely intereſting; for, beſides the great number of objects which we collected, and the obſervations we had occaſion to make, we were ſurpriſed to ſee a country exceedingly fertile, yet almoſt a deſert, and often volcanic, exhibiting, at every ſtep, veſtiges of ancient cities. We croſſed the Euphrates and the Tigris on wretched wooden boats; and two rivers, which flow from the mountains of Curdiſtan, on boats formed of a number of inflated ſkins joined together. I ſhall deſcribe, with ſome minuteneſs, this ſimple method of croſſing rivers, becauſe it might be employed with advantage in Europe, on account of the facility and trifling expence of tranſporting a great number of ſkins; of inflating them in a moment, and uniting them firmly together by means of the branches of trees; and of conveying, in this manner, over the largeſt rivers, a whole army without any danger.

When we arrived at Bagdad, the pacha was ſo ill that two Perſian phyſicians, who attended him, had given over all

* Read in the Sitting of the National Inſtitute, February 14th. By C. Olivier.

hopes

hopes of his recovery. His aſtrologer had read in the ſtars the fatal ſentence; the kiaya pacha and ſome of the grandees were already forming intrigues to ſucceed him, and the janiſſaries were taking up arms to ſell their ſervices to the higheſt bidder. The Arabs of the deſert, and of Meſopotamia, waited only for the moment of his death to plunder the caravans and rob travellers. This city was threatened with a general inſurrection. Commerce was ſuſpended; and it was impoſſible for us to continue our journey. The pacha begged us to give him our advice, until we ſhould have an opportunity of ſetting out for Perſia. We thought ourſelves bound to comply with his requeſt, and had the ſatisfaction to reſtore him to health in the courſe of a few days. From that moment order was every where re-eſtabliſhed; and the kiaya alone paid, with his head, for the ſteps he had taken to aſſume the place of his benefactor. The pacha ſhewed us every mark of gratitude, made us a preſent of two fine Arabian horſes, and gave us letters of recommendation to the khan of Kermancha, and the miniſters of the king of Perſia.

We did not delay a moment to provide ourſelves with Perſian dreſſes, and whatever elſe was neceſſary; and departed on the 16th of May 1796, with the regret of leaving behind us a box containing ſeveral very valuable jewels, deſtined as preſents to the Perſian court, which the envoy of the republic at Conſtantinople was to have ſent after us.

The uſual heat at Bagdad, during ſome hours of the day, is from 110° to 113° Fahr. On the day of our departure the thermometer was already at 99½° Fahr. We had here an opportunity of ſeeing a phenomenon which explains the origin and cauſe of that ſingular and tranſitory wind which deſtroys men and animals, if proper precautions are not taken to guard againſt its effects.

On our arrival at Kermancha, the firſt city of Perſia, we waited on the khan, made him acquainted with the object of our travels, and delivered to him the letter from the

pacha of Bagdad. The khan aſked us many queſtions reſpecting the different ſtates of Europe, with which he ſeemed to be little acquainted, and reſpecting our manners and cuſtoms. He dwelt moſt on the countries of the Ottoman empire which we had traverſed, and particularly Bagdad, becauſe in that city the aſhes of Ali are preſerved. He gave orders to one of his officers to accompany us to court, and procured us the neceſſary paſſports. On the 1ſt of June we arrived at Teheran, where we learned that the king and his miniſters had ſet out in the beginning of ſpring on an expedition, the object of which was ſuppoſed to be the conqueſt of all Chorazan.

I was highly pleaſed with the idea of undertaking this journey, and I conſidered it as a fortunate circumſtance that the king was at the head of an army in one of the moſt intereſting provinces of Perſia; into which no European traveller had penetrated, and which produces the moſt remarkable plants, as well as the greater part of the drugs brought to us from the Eaſtern countries; but C. Bruguiere had been ill for a long time, and was threatened with a dyſentery. The dragoman himſelf was indiſpoſed, and reaſons were not wanting to diſſuade me from undertaking the journey. "It is not poſitively known," ſaid ſome, "where the king is; and it is dangerous to approach the army in this country, becauſe people are plundered, and even killed, before they can be known and protected. It will require more than a month to reach Chorazan, and the king muſt return in two." Theſe reaſons did not counterbalance the advantages which were likely to reſult, from this journey, to natural hiſtory and geography; but I reflected that the health of my colleague was becoming daily worſe, and that he was incapable of ſupporting the fatigues of travelling ſo far, during the hotteſt ſeaſon of the year. It would have been neceſſary to traverſe the Mazandaran, a hot, marſhy, and extremely unhealthful diſtrict; and beſides this, the dragoman refuſed to accompany us. We then agreed to wait

wait for the king in the environs of Teheran, in order that we might take advantage of the ſeaſon proper for reſearches in regard to natural hiſtory; for collecting ſeeds, and for enabling C. Bruguiere to re-eſtabliſh his health with more facility.

We were obliged to negotiate, and to make ſome pecuniary ſacrifices, before we could obtain permiſſion to quit the town, and reſide in a village at the bottom of mount Albours. Teheran contained hoſtages from all the great cities of the empire, whom Mehemet had cauſed to aſſemble there for his ſecurity; ſo that people might enter the city, but could not depart from it without the expreſs leave of the governor; and the latter did not let ſlip ſo fine an opportunity of forcing us to expend a little money. As we foreſaw that the preſents left behind might be retarded, and not even reach us, we thought it prudent not to make any mention of them. We had it in our power, indeed, to offer the governor a watch and ſome arms; but we ſhould thus have entered into an engagement to give other preſents to his principal officers, and, on the king's arrival, having nothing ſufficiently beautiful to offer to his miniſters, and our preſents being detained at Bagdad under a pretence that the roads were not ſafe, we ſhould have been conſidered as impoſtors, and ſhould have loſt that confidence which our conduct ought to have inſpired.

The king, after taking poſſeſſion of Meſched and all Chorazan, and after having deſtroyed Charok-Shah the laſt deſcendant of Thamas-Kouli-Khan, and carried away his treaſures, returned to Teheran. He made his entry into that new capital towards the end of September 1796; and, two days after, we had an audience of the prime miniſter, with whom we had reaſon to be ſatisfied. We endeavoured to ſecure the friendſhip of the chief ſecretary, an active, judicious, enterpriſing man, and as well informed as could be expected in Perſia. We ſpoke to him of the new government eſtabliſhed in France; and, at the ſame time, made him

him acquainted with its resources, population, triumphs and power. We received from him some interesting details respecting the manners, religion and government of the Persians, as well as a circumstantial history of the troubles which had desolated that unhappy country since the dethronement of Shah Hussein, and particularly since the death of Nadir Shah.

On the 4th of October we obtained from the minister an audience to take leave; and, some days after, his principal secretary gave us a letter addressed to the French republic, a copy of which I immediately dispatched, reserving the original, which I have since presented to the directory.

We now made haste to complete our observations and to return to Bagdad, as we already foresaw the storm which still involves that country in all the horrors of a civil war. We quitted Teheran on the 15th of October, and pursued the road to Ispahan. We had made an ample collection of objects of natural history, and of medals. We had acquired also very correct information respecting the population, revenues and forces of Persia; the late revolution, and the state of its commerce. Our travels, however, would have been incomplete, had we not seen the ancient capital of the empire, and the seat of the sophis. We remained a month at Ispahan, and on the 21st of December arrived at Bagdad.

Some European travellers have traversed Persia, and have given us accounts more or less correct of that empire. They have made us acquainted with the industry and commerce of the Persians; given us long details respecting the religion and followers of Mahomet; and have described the palace and gardens of Shah Abbas and his successors, as well as the public edifices of Ispahan. But the history of the troubles of Persia since the death of Nadir Shah; the changes in manners, agriculture and industry, which must have been effected there by intestine wars, that continued for more than sixty years; the formation of a new empire, more powerful than Persia itself, which extends from Candahar to

Cashmire,

Caſhmire, from Caboul to the country of the Moguls, comprehending the fertile banks of the Indus, cannot fail of giving new intereſt to a new narration. In regard to natural productions, it will be ſeen, by an account of the different objects which I ſhall not fail ſoon to publiſh, how little they are known, and how curious and important the greater part of them are.

Perſia is an elevated country, covered with ſnow in winter from the Caſpian ſea to Iſpahan; and in ſummer, dry and exceedingly warm. It conſiſts of mountains remarkably high, and of immenſe plains, for the moſt part uncultivated. What muſt aſtoniſh every traveller is, that throughout the whole empire no production can be obtained without watering: neither corn nor vines grow there but by means of water. No trees or ſhrubs are ever ſeen, but ſuch as have been planted, reared and watered by the hand of man. Water is every where neceſſary; and yet in this country it is naturally wanting. It was requiſite, therefore, that the induſtry of the inhabitants ſhould ſupply this deficiency by ſubterranean channels, which convey water from all quarters, and end at a common reſervoir. By taking advantage of the declivity of the ground, they then draw off different ſtreams, near which they form habitations more or leſs conſiderable, according as the water, more or leſs abundant, admits of a greater or leſs degree of cultivation.

Though wounded, at the diſtance of ſix days journey from Bagdad, by a band of Curdes, while aſſiſting my colleague when about to fall into their hands, I was, however, ſoon able to continue our journey; but C. Bruguiere, whoſe life was almoſt daily threatened in Perſia, and whoſe health was ſtill uncertain, could not for a long time be prevailed on to proceed. Nearly ſix months elapſed before I was able to perſuade him to ſet out in order to return home. Several times, on the approach of the fine ſeaſon, did I threaten to leave him; but I could never reſolve to do ſo, as my conſcience

ſcience would not have ceaſed to reproach me, had my companion, after my departure, terminated his career at a diſtance from his friend and fellow traveller.

During the time I reſided at Bagdad waiting for the perfect re-eſtabliſhment of C. Bruguiere's health, I employed myſelf in collecting different materials for a hiſtory of our travels. I have ſeen the ruins of Seleucia, Cteſiphon, the ſite formerly occupied by the celebrated Babylon; the towers called thoſe of Nimrod, which neither time nor the hand of man has been able entirely to deſtroy, and which ſtill excite the admiration of travellers.

I had in Egypt and Syria obſerved the Arabs, that nation ſo ſingular, and reſpecting whom travellers have ſpoken ſo differently. I had ſtudied their manners, their cuſtoms, and the form of their government. It ſtill remained for me to live among them, to travel with them, to frequent their tents, and to receive from their hands ſimple, frugal, and wholeſome food.

As particular circumſtances obliged me at Bagdad to exerciſe the functions of a phyſician, I readily embraced that opportunity of ſeeing the interior part of the Mahometan habitations, and of becoming acquainted with the ſtate of their harems, and the women ſhut up in them. No traveller, perhaps, has been able to collect, in this reſpect, ſo many ſingular anecdotes.

We departed from Bagdad on the 1ſt of May 1797, in company with a caravan deſtined for Aleppo. We remained ſixty-five days on the banks of the Euphrates, and in the deſert employed our time in preparing plants, collecting inſects, ſkinning birds and quadrupeds, and in making obſervations on the Arabs; the climate, ſoil, and productions of theſe countries. We made only a ſhort ſtay at Aleppo, where we found a letter from C. Aubert Dubayet, in which, after ſome compliments on account of our conduct, he requeſted we would return by the ſhorteſt route to France.

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This invitation was perfectly agreeable to our wiſhes; but it was indiſpenſably neceſſary that we ſhould paſs through Conſtantinople. Could we leave behind us a ſcattered collection, the fruit of five years labour and obſervations, expoſed to the dangers of the ſea and of dilapidation? Is it not certain that objects of natural hiſtory, almoſt all of a periſhable nature, muſt be taken care of during quarantines by hands accuſtomed to manage them? How eaſily might manuſcripts have been carried away? We had left ſome boxes under the care of a merchant at Conſtantinople, and others in an apartment of the ambaſſador's palace. There was a great number at Scio, and ſome at Latakia. We conſidered it as our duty to unite the whole, and to convey them all to Paris ourſelves, in order that it might be ſeen, on our arrival, whether we had accompliſhed the views of government, and whether we had not deceived the expectations of the learned.

We wrote to the ambaſſador to make him acquainted with the motives which induced us to take the way of Conſtantinople. We wrote, at the ſame time, to the conſuls of Tripoli and Cyprus, begging them to inform us when the firſt ſhip ſailed for the Archipelago; after which we repaired to Latakia, where we found only a wretched Venetian ſhip, in which the conſul adviſed us not to embark, as the Algerines, for ſome time paſt, had inſulted the flag of that expiring republic. We then reſolved to proceed to Cyprus, and to traverſe that iſland, though in the moſt dangerous ſeaſon; to repair afterwards to the coaſt of Caramania, and to proceed thence to Conſtantinople, by croſſing Aſia Minor. This journey was one of the moſt intereſting we undertook, both in regard to natural hiſtory and the information we collected reſpecting the manners of the Turks, in a country little known, little frequented, and yet ſo worthy of attention.

We arrived at Conſtantinople in the end of October, and ſhould have departed thence in the Serieuſe, ſome time after, had

had we received our boxes from Scio, and thoſe we left at Cyprus. The ambaſſador was employed in procuring us a paſſage in the Brune to Athens and Corfu, juſt at the time of his death. After that event, all our efforts to procure a ſafe and direct paſſage to France being uſeleſs, we thought we ſhould be ſheltered from all danger, and free from all reproach, if we proceeded to our iſles in the Levant, by croſſing the iſthmus of Corinth. It was certainly of much importance for us not to fall into the hands of the Engliſh, whoſe ſhips covered the Mediterranean. It would have given us great pain to ſee our enemies profit by our labours, and reap the fruit of all our dangers and fatigues.

We wrote to C. Carra Saint Cyr, *chargé d'affaires* of the republic at the Ottoman Porte, to inform him of our plan, and obtain his approbation; and at the ſame time to aſk ſome pecuniary aſſiſtance, and make him adjuſt the ſtatement of the ſums advanced to us ſince our arrival in the Levant. We received a favourable anſwer, and ſuch as was ſuited to our circumſtances.

It may not be ſuperfluous here to obſerve, that we had for a long time reminded the Porte of the ſervices we had rendered to it in regard to the pozzolana; a ſervice it perhaps thought it had ſufficiently rewarded by the flattering letter which the Reis Effendi charged us to deliver to the miniſter of foreign affairs, accompanied with a preſent of 2000 piaſtres. We ſhould certainly have refuſed, from any other government, a ſum ſo ſmall and ſo ill proportioned to our labour, expences, and the importance of the diſcovery, and, in particular, ſo far below the promiſes made to us; but a government ſo little ſuſceptible of honeſt and generous conduct, would not have been ſenſible of the motive of our refuſal.

We left Conſtantinople with a favourable wind on the 30th of April, in a Turkiſh boat we had hired; touched at one of the caſtles of the Dardanelles, and different points of

the Troade, and, for the ſecond time, traverſed that fertile country. We paid a viſit to the ancient ſite of Troy; ſaw the ſources of the Scamander; went along the ſhores of the Simois, and thence proceeded to examine the ruins of the Troy of Alexander. We ſtopped half a day at Ipſera; went on ſhore at Cape Sunium to ſee the remains of the temple of Minerva, and arrived at Athens on the 6th of May. We did not remain above twenty days in that city, which exhibits ſo many beautiful monuments, and calls to remembrance ſo great events. I have brought with me a plan of the ancient and modern city, by Fauvel; and one of Marathon, which I traced out on the ſpot. I collected information reſpecting the preſent ſtate of Athens and the neighbouring country, to compare it with what it was formerly. I have ſeen Mount Hymettus, the marble quarries of Pentelica, the cities of Eleuſis and Megara. We paſſed through the Straits of Salamis, where the Perſian fleets were deſtroyed; and traverſed the Iſthmus to embark again on the Gulph of Lepanto, from which we repaired to Patras.

It was time to terminate our obſervations on the Ottoman empire, and to quit theſe countries, now barbarous, though formerly the ſeat of the arts, ſciences and philoſophy. It was time to place ourſelves under the ægis of the republic. We arrived at Corfu on the 14th of July, after having touched at Cephalonia, Ithaca, and Parga. We performed quarantine for 21 days. It was not yet finiſhed, and we began to think of continuing our journey through Italy, though embarraſſed with a conſiderable collection, when C. Comeyras, commiſſary general of the directory, arrived. We immediately applied to him in order to procure a paſſage to Ancona. He gave us reaſon to hope that he would ſoon aſſign to us for that purpoſe a ſmall veſſel belonging to the republic; and, in the mean time, I traverſed the iſland and environs, ſometimes alone, and ſometimes with my colleague, to procure information reſpecting the natural productions of

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the country; the ſtate of agriculture, and the improvements that might be made in it; its ports and harbours; the timber of Epirus fit for ſhip-building; the commerce of theſe diſtricts, and the manners and opinions of our new French ſubjects. On the 23d of Auguſt, and 6th of September, I delivered to C. Comeyras two memoirs, the one being a continuance of the other, in order that he might tranſmit them to government.

On the 9th of September we ſailed in the Brune frigate for Butrento, where we ſpent the day, and arrived at Ancona in the courſe of a few days. My colleague, who had been almoſt always indiſpoſed and in a ſtate of ſuffering ſince our tour through Perſia, here terminated his career, on the 3d of October 1798, in conſequence of a malignant fever brought on by fatigue. He has left a family in want, whom I doubtleſs have no need of recommending to the benevolence and juſtice of the government.

I have brought with me, from the countries I have travelled through, a pretty large collection of plants, ſeeds, quadrupeds, birds, reptiles, river fiſh, inſects, ſhells and minerals, as well as of medals, engraved ſtones, and other objects of antiquity. I have Egyptian idols and mummies; a ſelection of drugs, moſt of them unknown in Europe; a ſeries of the medicines employed in Perſia; and, in the laſt place, ſome rare and valuable manuſcripts. I have juſt ſent to the national garden of plants, ſeeds from Perſia, Meſopotamia, the deſert of Arabia, Syria, Cyprus, Aſia Minor and Greece, in order to be there ſown and cultivated. A great number of thoſe which we ſent home before, have been already reared, and are in a thriving condition.

III. *Method of preparing the Dutch Turnſol Blue**.

IT is well known that the Dutch kept their proceſs for preparing turnſol blue a very great ſecret; and, in order to miſlead the public, pretended that it was made from rags dyed with the juice of the ſun-flower (*Helianthus*), from which it obtained its name. Since the late revolution, however, in Holland, the true method employed by the Dutch for preparing this colour has been diſcovered, and the proceſs is as follows:—That kind of lichen called orchil (*Lichen rocella*), or when that cannot be procured, the large oak moſs, after being dried and cleaned, is reduced to powder, and by means of a kind of oil-preſs the powder is forced through a braſs ſieve, the holes of which are ſmall. The ſifted powder is then thrown into a trough and mixed with an alkali called *vetas*, which is nothing elſe than the aſhes of wine lees, in the proportion of half a pound of aſhes to one pound of powder. This mixture is moiſtened with a little human urine, for that of other animals contains leſs ammonia, by which a fermentation is produced; and the moiſtneſs is ſtill kept up by the addition of more urine. As ſoon as the mixture aſſumes a red colour, it is poured into another trough; is again moiſtened with urine, and then ſtirred round in order that the fermentation may be renewed. In the courſe of a few days it acquires a blueiſh colour, and is then carefully mixed with a third part of very pure pulveriſed potaſh; after which the mixture is put into wooden pails, three feet in height, and about half a foot broad. When the third fermentation takes place, and the paſte has acquired a conſiderably dark blue colour, it is mixed with chalk or pulveriſed marble, and ſtirred well round that the whole may be completely united. This laſt ſubſtance gives the colour no higher quality, and is intended merely to add

* From the *Handlungſzeitung*, by J. A. Hildt, for December 1798.

to the weight. The blue, prepared in this manner, is poured into oblong ſquare iron moulds; and the cakes, when formed, are placed upon fir boards on an airy floor in order to dry, after which they are packed up for ſale.

IV. *On the apparent Converſion of Silver into Gold. By Profeſſor* HILDEBRANT, *of Erlangen* *.

THOUGH gold and ſilver have this common property, that they ſhew little affinity for oxygen, and their calces can therefore be revived merely by ignition; their difference in other reſpects is ſo great, that ſcarcely any two metals can be more unlike. Not only is their colour totally different, and the ſpecific gravity of gold far greater than that of ſilver, but ſilver, in the dry way, forms a perfect union with ſulphur; and in the wet way, with the ſulphuric and nitrous acids; whereas gold has no affinity for theſe ſubſtances.

If the tranſmutation of metals were therefore poſſible, the converſion of ſilver into gold would be very improbable. We muſt, however, conſider nothing impoſſible in nature, the impoſſibility of which cannot be demonſtrated *à priori*. Each century, and, in the preſent active age, every ſhort period of a century, diſcovers new phenomena, ſome of which are of ſuch a nature that they would be conſidered as impoſſible, were not their reality fully confirmed by experience.

I entertain no dread then of being ridiculed by the unprejudiced philoſopher, if I call the attention of chemiſts to a phenomenon in which ſilver appears to be converted into gold. It is a well known proceſs, which I repeat in every courſe of my Lectures, to diſſolve ſilver that contains copper in pure nitrous acid, to precipitate the pure ſilver by common ſalt (muriat of ſoda), in the form of horn ſilver (muriat of ſilver), and then to ſeparate the ſilver from the latter by fuſion with mineral alkali. An experienced chemiſt aſ-

* From *Algemeine's Journal der Chymie*, by A. N. Scherer, 1799.

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ſured me, that when ſilver is revived in this manner, it is in part converted into gold. Since that time I have frequently re-diſſolved in pure nitrous acid the ſilver which I obtained from horn ſilver, and always found a ſmall quantity of black powder remaining at the bottom, which ſeemed to have all the properties of gold.

My proceſs for reviving the horn ſilver is perfectly ſimple: I pour into a deep crucible a bottom of alkali an inch high, and form in it a hemiſpherical cavity with the round end of a cupel rammer. I then put the horn ſilver, well pounded, and mixed with as much alkali (neither of them moiſtened), into this cavity, cover the whole with a thin ſtratum of alkali, and apply a ſlow heat, till the whole maſs comes to red fuſion; by which means the revived ſilver is enabled to ſink down and collect itſelf at the bottom. As vegetable alkali (potaſh) produces the ſame effect as the mineral (ſoda), I employ the former becauſe it is cheaper. I find by experience, that, to form a moiſt ball of the horn ſilver and alkali, is not only unneceſſary, but even prejudicial; for the moiſt mixture is tenacious, and unavoidably adheres to the fingers and the veſſels, thereby cauſing waſte. As the horn ſilver is ſo extremely fuſible, and at the ſame time a flux for earths, and as it eaſily penetrates the crucible, the principal object in reviving, according to the above method, is to increaſe the heat by very ſlow degrees, ſuffering the charcoal to burn only gently for two hours around the bottom of the crucible, that the horn ſilver may be in a ſtate of fuſion before the crucible has been long ignited. By theſe means the alkali is enabled to join itſelf gradually to the muriatic acid, and at the ſame time ſo completely that, when the heat is increaſed till the alkali is in a red fuſion, there is no longer horn ſilver but metallic ſilver preſent, which therefore may come in contact with the crucible without any danger.

For diſſolving the revived ſilver I employ nitrous acid, which I firſt purify ɔ barytes from the ſulphuric acid, and

afterwards by ſilver from the muriatic acid. It cannot here be diſcovered how gold could be conveyed to the ſilver by the ſolvent and precipitant employed; and therefore, to appearance, a part of the ſilver is actually converted into gold. Enlightened chemiſts, however, will ſcarcely believe in this tranſmutation, and will rather ſuſpect ſome deception. I confeſs that I do not myſelf believe in it, and I explain the appearance of gold from the revived horn ſilver in the following manner:—Notwithſtanding the great difference between gold and ſilver, ſome ſilver is almoſt always preſent in pure gold; and a little gold is in like manner almoſt always preſent in pure ſilver (in thoſe commonly called pure). The caſe is the ſame in theſe metals when worked, particularly in coins, even where they are not alloyed one with the other. In all the ducats I have hitherto tried, even in thoſe of Holland, I found, on diſſolving them in aqua regia, a little ſilver depoſited in the form of horn ſilver. In all French crowns, even in the fine Harz florins which are perfectly free from copper, I found a little gold, which, when they were diſſolved in the nitrous acid, was thrown down in a dark coloured precipitate, which could not proceed from the alloying. Dutch ducats, for example, are not, as far as I know, alloyed with ſilver; and no one certainly will believe that the gold found in the Harz florins and French crowns was purpoſely added to them. The metal of theſe coins has from nature a ſmall portion of foreign metals; the gold a little ſilver, and the ſilver a little gold, as long as it is not purified by quartation—or the gold by antimony. If a ſolution therefore be formed of ſuch ſilver, the gold remains undiſſolved, and gradually depoſits itſelf at the bottom as a fine black powder.

It may be readily comprehended, that every chemiſt, unleſs he has very little experience in ſuch proceſſes, when he wiſhes to precipitate ſilver as horn ſilver, will firſt pour off and filter the clear ſolution of ſilver and copper from the black gold powder, before he adds the muriat of ſoda. On

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a haſty view, one might conclude, that the gold which is afterwards found in the ſame ſilver, when revived from horn-ſilver, could not be a portion of the ſame gold of which a part had been depoſited on the firſt ſolution of the impure ſilver. But is it not poſſible that even when the ſolution has ſtood a conſiderable time, and the greater part of the gold powder has depoſited itſelf, a portion may ſtill remain ſuſpended, and its particles be ſo minute as to paſs through the filtre? A well diluted ſomewhat ferruginous acid, after diluted pruſſiat of potaſh (phlogiſticated alkali) has been added to it, looks at firſt blue, but perfectly tranſparent; yet in the courſe of a few days real Pruſſian blue depoſits itſelf at the bottom as a fine powder, and then the fluid loſes its colour. The particles of the precipitate are at firſt too fine, and appear under too ſmall angles, to be diſtinguiſhed by the eye as ſolid bodies amidſt the fluid. The caſe is the ſame with ſiliceous earth, when the liquor of flints is much diluted; and alſo with gold calx precipitated with the mineral alkali from aqua regia, where the tranſparent colourleſs ley poured off from the firſt precipitate, and filtred through eight folds of paper, at the end of ſeveral days again forms a black depoſit.

As my time is fully occupied with the proceſſes neceſſary for my Lectures, I have not leiſure at preſent to examine this circumſtance by a ſeries of experiments. But, perhaps, ſome other chemiſt, by repeatedly diſſolving ſilver and precipitating it by muriatic ſalt, may be enabled to confirm or refute my opinion.

Obſervations on the foregoing Paper, by Dr. SCHERER.

THE preceding remarks are greatly confirmed by many obſervations already made public. Thus Homberg, in ſupport of his aſſertion that all gold has been once ſilver, quotes the following experiments: "If you fuſe a hundred times in ſucceſſion 8 or 16 ounces of ſilver, which, by previous quartation, you are convinced contains no gold, keeping it each time at leaſt an hour in fuſion, and afterwards ſeparate

it by the quart, you will be able to ſeparate a conſiderable quantity of gold, which was not before in it, becauſe you ſeparated by the firſt quartation all the gold it could contain. Farther, diſſolve 8 oz. of ſilver in aquafortis, ſeparate all the undiſſolved part, add to it common ſalt, and edulcorate the precipitate you have obtained and dry it. Mix with it half its weight of well purified regulus of antimony prepared with iron, and diſtil the whole in a retort over a ſlow fire. About 3 oz. or more of the butter (muriat) of antimony will paſs over, and, when the fire has been ſtrengthened to the utmoſt, the ſilver will remain with a part of the regulus at the bottom of the retort. Fuſe this ſilver in a crucible until no more vapour ariſes, and until all the regulus is evaporated. Then fuſe this ſilver once or twice more in new crucibles with a little borax and ſaltpetre, and it will become much more beautiful and finer than cupelled ſilver. If you then granulate this ſilver and diſſolve it in aquafortis, a great many black ſcales will remain behind, and, on fuſing, you will find them to be gold. If you repeat this operation once more with the ſame ſilver and a like regulus, a few black flakes only will remain; and the third time there will be none *." Boerhaave ſays, in his Elements of Chemiſtry, "If two parts of the precipitated calx of ſilver, well mixed by trituration with one part of regulus of antimony, be diſtilled in a retort in a ſand bath, pure butter of antimony, equal in weight to the regulus added, will paſs over. The ſilver, with part of the regulus, will remain at the bottom; and, when reduced, always gives real gold †." Kunckel ‡, in like manner, ob-

* See *Memoires de l'Academie de Paris* for the year 1709, p. 133; and Crell's *Neues Chem. Archiv.* vol. i. p. 30.

† Si enim calcis præcipitatæ argenti partes duæ, cum reguli antimonii parte una, tritu bene miſtæ diſtillant ex retorta, igne arenæ, prodit purum butyrum antimonii tanto pondere, quo fuit regulus admiſtus. Argentum cum parte reguli manet in fundo, *et reductum ſemper dat verum aurum.* Elementa Chemiæ. Lipſiæ, 1732. Tom. ii. p. 413.

‡ See his *Chem. tractätlein.* p. 146.

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tained gold by treating ſilver with common ſalt. M. Cappel, by treating ſilver with arſenic, obtained from four ounces ten grains of gold *. Guyton confirms this experiment, and obſerves that, in this manner, 8 grains of gold are obtained from 1000 grains of ſilver †. The arſenic, in the laſt caſes, was combined with gold. Some very important reſults, in regard to this ſubject, might be obtained by examining the works of the ancient alchemiſts, as all their aſſertions reſpecting real tranſmutation might be explained by mere ſeparation, without allowing them ſo much as ſome have done ‡.

V. *Hiſtory of Aſtronomy for the Year* 1798. *Read in the College de France, Nov.* 20. *By* JEROME LALANDE, *Inſpector and Dean of the College, and formerly Director of the Obſervatory.*

[Concluded from the laſt Volume, page 389.]

I SAW at Straſburgh the firſt ſheets of a new map of Swiſſerland conſtructed by M. Weiſs, to whom M. Tralles communicated his triangles and baſes. This map is extremely well engraved, and gives us an intereſting topography of Helvetia.

I paid a viſit, in my paſſage, to the obſervatory of Manheim, which had afforded me ſo much pleaſure in 1791; but I found the inſtruments packed up in boxes and depoſited in vaults which the bombs had ſcarcely reſpected, and waiting there for peace, without which neither ſcience nor happineſs can exiſt. The miniſter d'Arberg, whom I requeſted to ſecond the zeal of M. Barry, ſhewed me every mark of friendſhip.

* Crell's *Neueſte entdeckungen*, vol. x. p. 136.

† Crell, *ut ſupra.*

‡ See Crell's *Neues Chem. Archiv*, vol. i. p. 212.

On the 15th of December 1797, Tycho Brahe's birthday, Dr. J. Ch. Burckhard arrived at my house. This able astronomer, born at Leipsic on the 30th of April 1773, came to reinforce the astronomical corps in France; and he is engaged in a German translation of Laplace's *Mechanique Celeste*, or *La Theorie de l'Attraction*, now in the press. This important work will give the last degree of perfection to our tables: two hundred pages of it are already printed.

On the same day I requested General Bonaparte to procure a good instrument for the observatory; and on the 19th of March the government granted me 2000 livres to purchase the seven and a half feet mural quadrant of C. le Monnier. We had long solicited good instruments for the observatory. C. Cassini, when director in 1785, had obtained a fund for that purpose from the minister Breteuil; but he had not time to make use of it. When I was director in 1795 I renewed my solicitations, and we were at length able to procure, the first time, for the most beautiful observatory in the universe, an instrument worthy of France*. The *Bureau des Longitudes* has sent thither an achromatic telescope; but that is not sufficient.

On the 30th of April I requested from General Bonaparte 10,000 livres to erect the mural quadrant and the meridian telescope of the observatory; and to make at Paris observations to correspond with those made by his astronomers. He departed too soon; but Neufchâteau, the French minister, is worthy of remedying that deficiency, and gives us reason to hope for the assistance we stand in need of. C. Lefrançais observed, with a complete circle, the solstices of this year; and I have seen, with pleasure, that the obliquity of the ecliptic corresponds, within a second or two, with the table which I gave in my Astronomy in 1792, and which is employed by most astronomers.

* The expence of building the observatory is estimated at a million of livres (40,000l.), without including the foundations and subterranean places eighty feet in depth.

On

On the 20th of June the Inſtitute decreed the prize for time-keepers, uſed in aſcertaining the longitude at ſea, to two chronometers made by C. Louis Berthoud, the going of which was obſerved by C. Meſſier and myſelf during ſix months. I carried one of them to Gotha; and I had the ſatisfaction of finding that a journey of two hundred leagues, in a carriage, did not make the change of a ſecond per day in its movement. The Inſtitute will propoſe, on the 4th of January, as the ſubject of a prize to be adjudged in two years, the theory of the comet of 1770, which was propoſed by the Academy in 1792. It has not hitherto been poſſible to calculate this comet but in an orbit of five years, and a revolution ſo ſhort is improbable.

The *Memoirs of the Inſtitute* for the Year IV. have appeared. They contain my *Theory of Mercury*, the reſult of forty years reſearches. This was the firſt memoir read in the firſt ſitting of the firſt claſs of the Inſtitute, on the 1ſt of January 1796.

The *Bureau des Longitudes* has publiſhed two volumes of the *Connoiſſance des Tems* for the years VIII. and IX., the additions to which were edited under my inſpection. It has determined that this work, in future, ſhall contain 500 pages, in order that we may inſert in it our obſervations and calculations. Theſe two volumes contain a number of important articles: new catalogues of the ſtars; tables of the moon's horary motion by Delambre; obſervations of Mercury by Vidal, the great and aſtoniſhing obſerver of that planet, to whom we are indebted for being able to ſay that the obſervations of Mercury, ſo rare and ſo difficult before his time, are at preſent as numerous as thoſe of the other planets, and leave nothing more to be wiſhed for on that head. He has alone done more than all the other aſtronomers of the world, either ancient or modern; and we may now diſpenſe with employing our attention on that ſubject. C. Vidal muſt make every other aſtronomer deſpair of exceeding him.

An interesting memoir, accompanied with a trigonometrical chart, serving to reduce the apparent distance of the moon from the sun, or from a star, to the true distance, and to resolve other questions of navigation, has just appeared, by J. R. Maingon, *lieutenant de frigate*. This ingenious chart, of great utility to the navy, was engraved by order of the minister, and published at the *dépot*. It will supply the place of the large charts of Margetts, and enable navigators to substitute operations with a pair of compasses for calculation.

The Geographical Ephemerides, undertaken by M. von Zach, of Gotha, at the commencement of the year, are a remarkable and useful work, as there are found in them every month curious observations; information respecting new books and charts, new voyages and geographical maps, such as those of Ireland, Africa and the Black Sea, of so much importance at a time when the public attention is directed towards these countries; also portraits, such as those of Herschel, Delambre, Sir Joseph Banks, &c.; in a word, every thing that can be interesting to astronomers, geographers and navigators. An extensive correspondence with all countries enables M. von Zach to form a mutual communication between learned men, even the most distant from each other. The only inconvenience is, that the German language is not sufficiently cultivated in the South. I have requested that a professor of German may be established in the *College de France*, as I am fully convinced of the importance of that language to various branches of science. No journal was devoted to astronomy and geography; and there was little reason to hope that any of the kind would be undertaken. Adelbulner and Bernoulli had attempted it without success. The high esteem in which M. von Zach is held, has given to his work a sufficient degree of reputation to ensure a sale, and consequently the continuance of this useful publication.

M. Martonfi has published, in Transylvania, a description

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of the obſervatory conſtructed by Count Biſhop Bathyani at Carlſburg or *Alba Julia*, called alſo Weiſſembourg and *Alba Carolina*.

M. Trieſnecker, of Vienna, has publiſhed a conſiderable work on eclipſes of the ſun and planets. He has calculated more than 150 obſervations, and the tedioufneſs of ſuch labour is well known. Scarcely any thing of the kind had been done in 1760, when I began to give an example of theſe calculations.

We are informed that a volume of Bradley's obſervations, ſo long expected, has been publiſhed at London. M. de Mendoza publiſhed, alſo at London, in 1797, reſearches in regard to ſolving the principal problems of nautical aſtronomy, with tables of verſed ſines for every ten ſeconds, and an auxiliary table which reduces the diſcovery of the true diſtance to the addition of five verſed ſines.

We have received the Ephemerides of Bologna for twelve years, from 1799 to 1810, by C. Mateucci, aſſiſted by C. Alamanni, Guglielmini, Sacchetti, and Canterzani the ſon. Since the commencement of the preſent century, the Academy of Sciences always publiſhed the Ephemerides for ten years. The laſt volumes are by Deſplaces, Lacaille and myſelf. I finiſhed at the year 1800, old ſtyle: the embarraſſed ſtate of commerce prevented me from immediately finding a bookſeller, and I therefore renounced theſe calculations. The aſtronomers of Bologna, more fortunate, have ſupplied this deficiency; and we ſhall have twelve years materials to aſſiſt thoſe who wiſh to make almanacks for that period.

The Ephemerides of Milan contain the reſult of an important labour of C. Oriani, on the method of correcting the elements of the tables of Mercury by obſervation; and many intereſting obſervations of C. Reggio and De Ceſaris.

M. Schröter, of Lilienthal, has publiſhed the ſecond volume of his *Aſtronomical Collections*, which, beſides other things, contains the apparent diameters of the ſatellites:

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nine-tenths of a second for the second; and one second and a half for the third.

M. Bode, at Berlin, has published a new volume of his Ephemerides for the year 1801, and a third supplementary volume; which contain many astronomical observations and memoirs, by the German, French and English astronomers. This work, like that of M. von Zach, is a repertory which no astronomer can be without.

We have received also a folio volume of logarithmic tables, published in 1794, by M. Vega, an officer of artillery in the emperor's service. Wlacq's tables, published in 1628 and 1633, had become exceedingly scarce; they were never reprinted, and yet they were often wanted. M. Vega has, therefore, rendered a great service to mathematics by republishing that valuable edition.

M. Schubert has published, in German, at Petersburgh, a large treatise of astronomy, in three volumes quarto, forming altogether nearly 900 pages.

The *Bibliotheque Britannique* of Geneva, for March and April, contain interesting details respecting the method employed by M. Blair to correct the difference of refrangibility in telescopes. Essential oils, a solution of corrosive sublimate in spirit of wine, with the addition of a little sal ammoniac; butter (muriat) of antimony diluted in a little ether or alcahol, mixed with a few drops of the muriatic acid, answered the purpose extremely well, when inclosed between two lenses of crown glass *. He formed a very good object glass with a solution of sal ammoniac and mercurial sublimate (muriat of ammonia and mercury). He has discovered that these different substances have not a like distribution of colours, as Boscovich remarked in 1765. In short, he has calculated the curves of glasses in such a manner as to correct the aberration of sphericity. This curious paper has been translated into French; but C. Leroy has kept

* Transactions of the Royal Society of Edinburgh, vol. iii.

back

back the manuscript for three years. We are obliged to C. Pictet for having made it known in his excellent collection the *Bibliotheque Britannique:* the author calls these telescopes *aplanatic*, or without error.

I have published a new edition of Rivard's Treatise on the Sphere and the Calendar; a well written elementary book, which has been useful for half a century. I have added to it the Republican Calendar, remonstrating against the deficiency of intercalation, as the decree of October the 3d 1798 was not in that respect agreeable to what I had delivered to C. Romme.

C. François de Neufchateau signalised his entrance into the ministry by ordering an Astronomical Bibliography to be printed. I brought with me from Germany a great many articles for this work; and I have found that no kind of bibliography can be complete without the co-operation of many persons in different countries. The period of the death of the great Copernicus was still a problem, which I resolved during my journey. He died on the 11th of June 1543, though Gassendi and Weidler say the 24th of May, and Planche the 11th of July, in the interesting collection of Ephemerides, where the memorable events of each day are recorded. I have caused more than sixty manuscripts to be examined in the national library. C. Legrand, one of the librarians of that celebrated repository, gave me an account of many others; so that we are making advances in this part of astronomical erudition.

We have received the observations of C. Ratte at Montpellier, C. Thulis at Marseilles, and C. Vidal at Mirepoix: those of the last-mentioned astronomer are of a very extraordinary kind. C. Vidal saw Mercury at the distance of three-fourths of a degree from the sun. The beauty of the climate, the perfection of his instrument, and the excellence of his sight, have produced observations as valuable as singular: I have spoken of them before.

The

The direction of the obſervatory at Amſterdam, belonging to the Society *Felix Meritis*, has been entruſted to M. Calkoen. He has been at Gotha to exerciſe himſelf with M. von Zach; and has begun a courſe of obſervations which will be uſeful in a country where none were ever made, though the want of a navy muſt induce the government to open their eyes in regard to an object ſo neceſſary to navigators. In vain did I go to Amſterdam in 1774; the Stadtholder and the Grand Penſionary promiſed every thing I wiſhed, and did nothing. M. van Swinden afterwards made ſome exertions, the effects of which begin to be felt.

C. Henry, who went from Manheim to Peterſburgh, has been able to reſtore activity to the obſervatory of that capital. He has cauſed to be erected the large mural quadrant by Bird, which had remained a long time in the packing-box, and which Rumouſki never made uſe of.

M. Piazzi, the aſtronomer of Palermo, is preparing to meaſure a degree. I have ſent him an exact metre, and they are employed on a complete circle.

The miniſter, Pleville-Peley, has increaſed the ſalaries of the aſtronomers belonging to the marine obſervatory at Marſeilles, where Thulis makes continued and important obſervations.

The ſurvey of Corſica, or deſcription of that iſland, begun thirty years ago, has been finiſhed. The large triangles were laid down by C. Tranchot; the minuter operations were performed by a great number of aſſiſtants. The miniſter of finance having commiſſioned me to examine this labour, I have reaſon to think that it is ſufficiently correct to be taken as a model, ſhould a like plan be adopted in regard to all the departments of France, which would be highly uſeful.

C. Perny, who had been ſent to Belgium, and who, ſince 1795, has formed forty triangles at Bruges, Ghent, Oſtend, Antwerp, Middelburgh, &c. has ſet out for the Batavian republic,

republic, which promiſes to furniſh him with every thing neceſſary for continuing that labour.

On the 24th of January the Inſtitute propoſed to the Directory to requeſt the different powers of Europe to ſend learned men to France, to aſſiſt in eſtabliſhing the new meaſures, and to ſanction that eſtabliſhment. Eleven have arrived from Denmark, Spain, Italy and Holland: from Denmark, M. Bugge, director of the obſervatory, and known by ſome important works; from Spain, Meſſrs. Gabriel Ciſcar and Auguſtine Pedrayes; from the Batavian republic, C. van Swinden and Æneæ, the former well known by ſome excellent works on natural philoſophy; from Tuſcany, M. Fabbroni; from Sardinia, Count Balbo, the miniſter at Paris; from Helvetia, C. Tralles; from the Ligurian republic, C. Moltedo; from the Ciſalpine republic, C. Maſcheroni, from whom General Bonaparte brought us what will ſerve as a leſſon to our moſt famous geometricians; and from the Roman republic, C. Franchini.

On the 23d of June the legiſlative body made a law, that the *Bureau des Longitudes* ſhould preſerve the original ſtandard of the metre, or of that new meaſure deſtined to be in future the type of all meaſures, and to prevent hereafter that confuſion which has hitherto prevailed in the meaſures of all countries.

Aſtronomy has ſo few proſelytes that I am happy in being able to ſay that Dr. Burckhardt, who came from Gotha laſt year, continues to labour with us at Paris, and that he is already one of our beſt aſtronomers.

Delambre had as aſſiſtants in his immenſe labour C. Tranchot, already well known by the great operations in Corſica, and young C. Pomard, who devotes himſelf to aſtronomy, and who cannot fail to make a rapid progreſs under ſuch a maſter. Aſtronomy has need of a few recruits; and I do every thing in my power to procure them; but the career is laborious, and not lucrative: this is ſufficient to explain why we have ſo few.

Blanpain,

Blanpain, born in 1779, who saw first at Marseilles the comet of 1797, announces, at the age of nineteen, as much zeal as knowledge. He is distinguished by his great learning and good moral qualities. Being obliged to apply to commerce, he is not yet able to indulge his taste for astronomy; but he calculates observations, and even makes some himself.

Young Bernier, of Montauban, applies also to the same science with success. I wished to get him sent out with General Bonaparte; but my application was too late.

C. Cotilon, though employed in the administration of domains, has come to lodge in the *College de France*, in order to labour along with us. His intelligence and zeal we often find useful.

On the 11th of November C. Cassini V. aged sixteen, who has come to reside in the observatory to pursue the traces of his ancestors, and who displays all the zeal which ought to be inspired by such an illustrious name, made his first observation in the observatory of the *College de France*, under the direction of C. Lefrançais. He will supply the place of Maraldi IV. who has left us.

After having spoken of our acquisitions, I must now speak of our losses. In the history of astronomy for the Year V. I announced the death of Toaldo, which happened at Padua on the 18th of November. As I published a particular eloge of that useful astronomer in the *Magazin Encyclopedique**, I shall here add nothing on the subject, except that his place is supplied in the observatory of Padua by his nephew, M. Chiminello, who was a long time his assistant.

Bertrand-Augustin Carrouge, an astronomer of great merit, died on the 29th of March. He was born at Dol on the 8th of October 1741. He calculated a thousand stars for the Celestial Globe published by C. Lamarche, successor to Fortin; and he made a great many calculations for the

* Vol. vi. p. 469.

Connoissances

Connoiſſances des Temps, and the ſecond edition of my Aſtronomy. He publiſhed ſeveral memoirs in the *Connoiſſances des Temps*; and a few days before his death he delivered to me tables for calculating the phaſes of the moon, better than thoſe which are in Bouguer's and La Caille's Elements of Navigation. They are in the *Connoiſſances des Temps* for 1801. He was exceedingly poor when he was appointed *adminiſtrateur general des poſtes* on account of the eſteem which Reveilliere-Lepaux, the director, had for his merit. His new appointment did not prevent him from applying to aſtronomy: talents rarely conduct to fortune; this only happens when power is united with knowledge.

Alexis John Peter Pauſton died on the 15th of June. He was born on the 10th of February 1732, near Luſſan, and is known by his *Metrology*, an immenſe collection of the meaſures of all countries, which appeared in 1780. I propoſed that labour, and furniſhed him with the greater part of the foreign meaſures; but he added many reſearches, diſſertations, and calculations reſpecting the ancient meaſures, population and agriculture. He employed himſelf on other parts of the mathematics, ſuch as the Screw of Archimedes. In the year 1781 he publiſhed a *Theory of the Laws of Nature*, in which he refuted Newton and Nollet, and eſtabliſhed a new geometrical foot of $123\frac{1}{4}$ lines. In that work he ſpoke of the pyramids of Egypt, &c. He was ſo fully perſuaded of the importance of his diſcoveries, that he aſſumed this motto: *E puteo veritas*. In the laſt place, he was employed in reducing into decimal meaſures the immenſe number of foreign meaſures, when the economy of government ſuppreſſed his ſalary, and plunged him into wretchedneſs and deſpair, which terminated in his death. The Inſtitute is juſt now ſoliciting government to grant ſome relief to his widow and children.

Beauchamp wrote to me, from Arles, that he had loſt his

brother, the companion of his travels through Arabia; and his pupil Hyacinth Receiveur, who diſplayed all that zeal and all thoſe good qualities which could be wiſhed. This loſs, a very great one to aſtronomy, threw Beauchamp into deſpair, and diſguſted him with a voyage to Arabia; but the miniſter ſent him to join Bonaparte and the men of letters aſſembled in Egypt, where he will certainly contribute to the ſucceſs of that important expedition, in regard to the geographical and aſtronomical parts.

M. Reccard, who had publiſhed various obſervations, died at Konigſberg on the 3d of October.

We have loſt lately alſo John Francis Calle. He was born on the 25th of October 1744, at Verſailles, where he received a good education, and acquired an early taſte for the mathematics. In 1768 he came to Paris, where he had an opportunity of being more thoroughly inſtructed. In 1774 he formed ſome diſtinguiſhed pupils for the ſchool of engineers, where the examinations were ſtrict, and admiſſion difficult to be obtained. In 1779 he gained the prize propoſed by the Society of Arts at Geneva, for eſcapements. In 1783 he completed his edition of *Gardiner's Tables of Logarithms*, which were exceedingly convenient, of great utility, and very correct; and which poſſeſſed advantages above all the others. In 1788 he was appointed profeſſor of hydrography at Vannes, afterwards at Dunkirk; and in 1792 he returned to Paris, and was for a few years profeſſor *des ingenieurs geographes* at the depôt of war. This place having been ſuppreſſed, he continued to teach in Paris, where he was always conſidered as one of the beſt mathematical maſters to whom pupils could apply.

In 1795 he publiſhed the new ſtereotype edition of the Tables of Logarithms, conſiderably enlarged with logarithmic tables of the ſines, according to the new decimal diviſion of the circle. Theſe are the firſt which ever appeared. Towards the end of 1797 he preſented to the National Inſtitute the plan

plan of a new telegraph, and a telegraphic language, accompanied with a dictionary of 12,000 French words adapted to it by a combination worthy of so able a mathematician.

These labours had injured his health; he had been a long time asthmatic, and notwithstanding his condition he published, that year, an excellent memoir on finding the longitude at sea, under the modest title of *A Supplement to the Trigonometry and Navigation of Bezout.* He died on the 14th of November 1798, leaving behind him a daughter, born at Vannes in 1793. According to a tradition in the family, he was descended from Descartes. I have not been able to obtain the genealogy of his family; but it is sufficient for the glory of Calle, that he has done honour to a name so celebrated.

VI. *Progress of Dr.* MITCHILL's *Mind in investigating the Cause of the Pestilential Distempers which visit the Cities of America in Summer and Autumn. Being a Developement of his Theory of Pestilential Fluids, as published to the World in* 1795, *and the succeeding Years* *.

IT had a long time appeared to him, that what had been mentioned by medical writers and lecturers under the names of *miasma* and *contagion*, was not treated of with the precision and certainty of knowledge, but discussed with all the indistinctness and conjecture of something only guessed at. And, while a student at Edinburgh, he supposed the doctrine taught in the university of the *sedative* operation of these poisons was true, until he heard from Dr. Brown, while attending his lectures, a contrary opinion.

Delivering his sentiments on *stimulants*, Brown had said, "Venena et contagiones incertiùs eòdem spectant." (Elementa Medicinæ, cap. 2. § XI.) This implied a doubt in Brown's mind, whether these classes of objects were stimu-

* From an American Correspondent.

lants or not. This doubt is repeated in § XIX. where, expreſſing his ideas of the manner the exciting powers act upon excitability, he ſeems to conſider poiſons and contagions as exceptions to the general rule of action: "niſi quod venena et contagiones excipi poſſe videntur." And although, in the two following paragraphs, he endeavours to ſhew that theſe ſubſtances are *ſtimulants*, and act upon the living body after the manner of other ſtimuli, ſtill he is ſo wholly ſilent as to their nature and conſtitution, and ſo entirely deſtitute of experimental proof or demonſtrative reaſoning, and withal ſo brief and general in his remarks, that nothing ſolid and ſatisfactory is afforded in that part of his work which treats of theſe matters.

In converſation with this original though unfortunate man, Dr. Mitchill acquired incorrect information on the matter of theſe poiſonous ſubſtances and their manner of acting; the ſum of Brown's reaſoning but tending to ſhew that, as all other ſubſtances according to his hypotheſis were ſtimulants, *poiſons* and *contagions* could not, from the nature and analogy of things, act in any other way than by ſtimulation too.

Thus it appeared to Dr. Mitchill, when he returned to America in 1787, that that field of phyſical ſcience, which included the production, operation, and extinguiſhment of poiſonous fluids, lay almoſt waſte and uncultivated. On turning over the Encyclopædia, there ſcarcely appeared a ſubject whoſe inveſtigation promiſed greater good to mankind, or fairer fame to the inveſtigator, than the hiſtory of theſe noxious productions. Not long after this time the Medical Society of the State of Delaware propoſed a prize-queſtion, "What was the hurtful power which produced the febrile diſtempers of that region?" And Dr. Mitchill was ſolicited by his friend Dr. Ed. Miller, then ſecretary of the ſociety, to compete for the prize. But being at that time engaged in the ſtudy of the law, and alſo in the politics of his country as a member of the legiſlature, he declined undertaking

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any thing of the kind; but obſerved, "that the miſchievous matter would be found to *be a gas*, and an analyſis of a portion of the atmoſphere there would not fail to detect *what ſort of gas it was.*"

Being devoted to other purſuits, the ſubject of poiſons hardly occurred to him afterwards, that he recollects, as a theme for contemplation, until the year 1795, when the following incidents ſet him ſeriouſly to thinking. While on a tour, that ſummer, towards the northern country, he had aſcended towards the ſources of the Kaats-kill, and been engaged among the ſublime and picturesque ſcenery of the Blue Mountains, in the State of New York. On a ſhoulder of the eaſtern ſide of a ridge, called the Pine Orchard, he very narrowly eſcaped being bitten by one of the rattle-ſnakes which infeſt that zone of the mountains. This ſerpent, of the full-grown and largeſt ſize, lay baſking in the ſun-ſhine. The voyager had walked within a foot and a half of him before he was diſcovered. The agitation and whizzing noiſe of his rattle led firſt to his detection. When ſeen, he was bent into a coil, and his head was erected apparently to ſtrike. The ſuddenneſs of the ſurpriſe, and the grand and novel aſpect of the animal, prevented for a moment the emotions of fear. Dr. Mitchill, however, was ſoon brought to his recollection by the cries and ſhouts of his companions, who were terrified at the extremity of his danger. In the mean time the animal crept quietly away, and Dr. Mitchill eſcaped unhurt. By the joint efforts of the company, this ſerpent and his mate were drawn from their lurking-place and killed. In the diſſection of their bodies, in which he was aided by William Cutting, Eſq. and others, Dr. Mitchill had an opportunity of examining their fangs, jaws, and receptacles of venom. So narrow an eſcape, as it induced him to reflect, led him afterwards to conclude, that there was very little of philoſophical information to be derived from Mead's *Mechanical Account of Poiſons*; and that in

Fontana's *Experiments*, the general exciting cauſe of plague and peſtilence had been left unexplored.

Another occurrence, during that excurſion, had directed his attention to the ſubject of poiſons. Dr. William M. Roſs, one of the party, had diſcovered that the *Rhus Toxicodendron* grew at the foot of the Blue Mountains. And a parcel of the leaves and ſtems of the plant were collected and carried home, with the intent of repeating Alderſon's experiments with this venomous vegetable, on perſons afflicted with palſy.

From this tour as he was returning to the city of New York, he learned with ſorrow at Paughkeepſie, a town eighty miles diſtant, that a malignant diſtemper had broken out during his abſence, and that among other perſons Dr. Malachi Treat, then phyſician of the port, had been carried off by it. Haſtening back with all ſpeed, he ſaw and converſed with a number of phyſicians, and found them divided in opinion, whether the yellow-fever, for ſo the diſeaſe was called, exiſted in the city or not. The majority ſeemed diſpoſed to doubt or deny the fact. A ſhort time, however, was ſufficient to convince all perſons whatever, that a ſad and terrible malady had made its appearance among the inhabitants.

Impreſſed as he was with ideas about poiſons, it appeared to him at once, that the exciting cauſe of the endemic ſickneſs of New York, was as much *a poiſon as the fluids ſecreted by the rattle-ſnake or the toxicodendron.* There was a difference, however, between the venom of peſtilence and the poiſons ſtrictly denominated *animal* and *vegetable*; becauſe the two latter were always the effect of vaſcular and glandular action with ſecretion in living bodies; whereas the former was the reſult of new combinations taking place in organized ſubſtances during their putrefaction and decay, without any thing like a ſecretory function. Herein, then, ſeemed to conſiſt the diſtinction between what might be called COM-

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MON POISON and SPECIFIC POISON; the one being produced *by the corruption of dead bodies*, the other afforded *by ſecretion going on in living ones*.

The deciſive method of gaining information concerning this COMMON POISON (venenum univerſale) muſt neceſſarily be an examination of every individual proceſs going on during the complicated work of animal and vegetable diſorganization. For this purpoſe Dr. Mitchill had planned a ſet of experiments. But, before undertaking theſe, he determined to watch the operation of the poiſon already produced, be it what it might, and obſerve in what manner it wrought the deſtruction of life. And, for this purpoſe, he remained in the city until the ſickneſs was abating; having omitted no opportunity to witneſs and collect facts as they occurred in the midſt of peſtilence and death.

Much obſervation, and in circumſtances where the perſons beſt calculated to make reſearches in ſcience rarely chooſe to expoſe themſelves, had led Dr. Mitchill to believe that the hiſtory of AZOTE, both in living and dead bodies, would throw a world of light upon this department of phyſics. Accordingly he went to Plandome, his country reſidence on Long Iſland, and became convinced, by experiments made on the air extricated in the abdomen of putrefying animals, that it was not merely *carbonic acid gas*, but conſiſted alſo of a large quantity of *azotic air*. It is remarkable, that, to avoid the obloquy too often levelled at experiments, he was obliged to conduct his proceſſes with all poſſible ſecrecy.

But *azotic air* alone ſeemed to poſſeſs too little activity to excite the horrid ſymptoms which conſtituted and characteriſed the diſtemper he had ſo lately witneſſed. Yet he knew, and there was no need of any new experiment to prove it, that this very azote did not always evaporate with caloric in the form of air; but in higher degrees of heat than that of October, when his experiments were made, this *acidifiable baſis* frequently connected itſelf with oxygen, and conſtituted

a very peculiar and deſtructive acid. Such an acid poiſon, he became perſuaded, had deprived Mr. Hewſon, Dr. Walſh, Mr. Jones, and other diſſectors, of their lives, by being admitted to a ſurface denuded of ſkin. Dr. Latham's fact of the ſervant poiſoned by touching an agnail on his finger with the fleſh of a putrid hare which he was ſkinning, is of the ſame kind. Immerſion of theſe carcaſes in ſtrong ſolutions of alkaline ſalts, or the mere ſprinkling them with pot-aſh or ſoda, would, he thought, have prevented thoſe unpleaſant accidents.

In ſuch caſes the product formed by the chemical union of azote with oxygen, mingled with more or leſs of water, and exiſting in a liquid form, poiſoned only when the parts of a living animal were brought into contact with it, as it beſpreads the ſurface which produced it. But Dr. Mitchill was convinced, that, in higher temperatures, when the ſurface of the earth was heated to 116 degrees, and even to 130 of Fahrenheit's ſcale, this liquid poiſon took on occaſionally a vaporiſic or aërial form, and was copious enough ſometimes to taint or infect a chamber, a houſe, a neighbourhood, or even a city. In the former caſe it injured none but thoſe who meddled with it, in the ſpots where it was produced; in the latter it roſe into the atmoſphere, and ſallied forth in queſt of prey, to diſtances indefinitely remote.

About this period of the inquiry Dr. Mitchill made an excurſion through a part of the State of New York, in conſequence of an appointment from the Society for promoting Agriculture, Arts and Manufactures, to explore the natural productions of the country, and eſpecially to determine whether any mines of coal exiſted in the neighbourhood of Hudſon's River. It did not appear that any conſiderable quantities of that article of fuel were to be found; but it was aſcertained, in the courſe of the expedition, that, in ſome of the manufactories, where the alkaline ſalt of burnt-wood is extracted to form the pot-aſh and pearl-aſh of commerce, there was enough of *oxygenated azote* in the atmoſphere to combine

combine with a portion of the alkali cryſtalliſing about the leteh-tubs, and to conſtitute ſalt-petre. The labourers at pot-aſh works, though much expoſed to night air, were ſeldom viſited by the ordinary fevers of the climate.

His attention being thus called to the properties of alkalis, was ſoon engaged in a more minute inveſtigation of the hiſtory of pot-aſh, by the following incident. Dr. Mitchill received from the Chamber of Commerce in Glaſgow, a letter complaining of the bad quality of certain barrels of pot-aſh and pearl-aſh exported from New York under the inſpector's brand, and proved by the bleacher at Paiſley, to whom it had been ſold, to poſſeſs hardly any qualities for whitening goods. This letter was accompanied with a notorial copy of the proceedings in a ſuit at law brought by the bleacher at Paiſley, plaintiff, againſt the commiſſion merchant in Glaſgow, defendant, for damages on account of having ſold him unmerchantable alkali; in which the Court gave judgment for the plaintiff. Theſe papers were ſubmitted to the Chamber of Commerce in New York. In conſequence of this, Dr. Mitchill was requeſted by the preſident of that body, a ſhort time after, to viſit with him the ſtores of the public inſpectors of pot-aſh and pearl-aſh in the city of New York. Among many other facts which were collected during this viſitation, it was related by the inſpectors, that, while the labourers in the pot-aſh ſtore kept themſelves at home and were within the influence of the alkali, the peſtilential air of the city had not affected any of them with diſeaſe; and Dr. Mitchill diſcovered afterwards, that if theſe very labourers expoſed themſelves to the noxious gas in the air abroad, they ſickened and died like other people.

While theſe things were under conſideration, the Legiſlature of the State aſſembled. At that time there was conſiderable converſation throughout the United States concerning the internal and domeſtic means of defending the country from invaſion by a foreign enemy. A man appeared with a project for ſetting up a manufacture of ſalt-petre in the neigh-

neighbourhood of the city of New York. On this project Dr. Mitchill was conſulted. The man's intention was to have petitioned for the privilege of having the dirt and ſcrapings of the ſtreets as a reward for keeping them clean. And from this maſs of nuiſance, *whoſe vapour in the hot ſeaſon gave the people their yellow fevers*, he intended to extract the nitre. After much conſideration of the project it was finally given up, as about that time the Secretary of State reported to Congreſs that a conſiderable quantity of that material had been brought to Philadelphia from ſome part of the weſtern country, and that any quantity required for the public defence might be procured from that quarter.

From a compariſon of all the facts which had thus come to his knowledge, Dr. Mitchill found that ſome of the principles in which he had been inſtructed, were not ſo well eſtabliſhed as they ought to have been. A number of the darling prejudices of his education were in danger of being overturned. And he, for ſome time, experienced no ſmall degree of affliction at the thought of rejecting much of what he had learned from books and lectures, concerning *acids* and *alkalis*, as groundleſs and untenable doctrine.

The fluids, whether liquid or aëriform, which *pot-aſh* could coerce, and which, as they emane from putreſying bodies, combine with that alkaline ſalt into nitre, thus appeared to be the very noxious miaſmata which vitiated the atmoſphere and rendered it ſickly and unwholeſome, when there was too little alkali or none at all to attract them. Theſe ſeemed to be evidence enough to convince him, and any body elſe who would examine the facts as he had done, that ſome combination of azote with oxygen was the ſimpleſt and moſt common form of poiſon.

At the ſame time he was perfectly aware that what he thus called a poiſon, was what mankind knew under the name of the *nitrous acid*; that *nitre was called a great antiſeptic*; that the acid was claſſed among the *mineral* acids, and was reckoned a *great antiſeptic too*; with a multitude of ſay-

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ings of this sort. He therefore apprehended that the old and rigid adherents to these names, and to the modes of thinking associated with them, would scarcely have patience enough to listen to any modernised, or, as they would term it, new-fangled statement of the facts. This difficulty was the more formidable, as it was found necessary eventually to make an innovation upon the French nomenclature itself.

To facilitate his own conceptions of things, rather than to affect novelty or attract proselytes, and also to render his expressions of these things more correct and easy, he proposed what he deemed an allowable amendment to the nomenclature, by expunging *azote*, *azotic*, *nitrous*, *nitric* and their *derivatives*, and taking *septon* for the radical term, with septous, septic, &c. as the preferable epithets. He conceived he had a right to make use of a nomenclature of his own, if he pleased; while others, if they preferred it, were at liberty to adhere to the old one.

[To be concluded in next Number.]

VII. *On the Use of Calcareous Stones in the Manufacturing of Crude Iron. By Mr.* DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

THE tenacious lava which is formed when iron ores or iron stones are fused without the addition of any other substance, first led to the application of calcareous earths, in various proportions; that a fluid sufficiently thin and divided might be formed, and the iron disengaged from its vitrid connections, precipitated to the bottom of the furnace. If the nature and mixture of the ore are well understood, the quantity of lime necessary to restore a just equilibrium of proportion in the lava will be readily attained; the metal, no longer incorporated with or suspended in the mass, will become completely revived, and flow from the furnace sufficiently purified from its earthy mixtures.

Before

Before this principle was underſtood and generally acted upon, the reſult in iron, from a given quantity of ore, muſt have been very uncertain, and its real value in the ſmelting furnace falſely appreciated: even at this advanced period of improvement, and attainment of ſcientific knowledge, it is much to be doubted if the principle of application of calcareous earths, in the blaſt furnace, is radically underſtood.

If an almoſt total want of knowledge concerning the nature, proportions, and variety of the earths united to the ores, prevail at the various manufactories of iron in Britain, we are not to wonder that the application of lime-ſtone is ſubject to great error, and productive of hurtful conſequences.

In the ſmelting proceſs the three great ſprings of action and government in the manufacture ought to be—a complete revival of all the metal contained in the ore—to confer value upon it, by reviving it ſaturated with a ſufficient quantity of carbon—and to uſe every endeavour to increaſe the quantity: ſtill, however, keeping in eye the produce of iron from the ore, and its quality; both of which may be eaſily impaired by too much eagerneſs after quantity.

To deprive an ore of its iron, ſo that no portion of it ſhall eſcape in the ſcoria unrevived, two things are indiſpenſible: 1. The metal contained in the ore muſt be preſented to a portion of fuel ſufficient to take up the oxygen from the metal. 2. As this revivification goes on in the manner of a metallic perſpiration upon the ſoftened ſurfaces of the ore, another agent ought to be preſent to facilitate the ſeparation, by uniting with the earthy parts of the ore; forming a thinly divided lava, no longer capable of retaining the globules of metal, or of preventing the congenial affinity of the carbonic principle from taking full effect for the improvement of the quality of the iron.

Experience has ſhewn, that an exceſs of any particular earth may be corrected by applying one oppoſite in its effects; and that the addition of lime, in various proportions, is found in moſt caſes to anſwer the deſired end: this once underſtood,

underſtood, it will be eaſily comprehended, that as iron ſtones and ores poſſeſs widely different proportions of mixture, their fuſion will be productive of vitrid ſcōriæ, various in their degrees of diviſion and tenacity. This leads to a concluſion, the juſtice of which cannot be doubted, that ſince the various mixtures of iron ores are productive of lava, which tends more or leſs to keep the iron from ſeparation, it becomes a neceſſary ſtudy to obviate the imperfections of ſuch mixtures, and at all times to regulate the proportion of the calcareous earth, from a knowledge of theſe mixtures and their effects, and not from an implicit reverence to the cuſtoms of a ſenior eſtabliſhment.

If the various claſſes of iron ſtones are fuſed in contact with charcoal, without the addition of a flux or ſolvent, the reſult is, from calcareous iron ſtone, a larger portion of iron proportioned to the intrinſic richneſs of the ore, than from argillaceous iron ſtone; and from the latter, a larger produce of iron, than from an ore whoſe chief mixture was ſilex: the ſcoria produced in the reſpective operations always demonſtrates, from its colour and opacity, the probable quantity of iron which ſtill remains to be taken up.

There are ſome calcareous iron ſtones which contain lime almoſt ſufficient to form the neceſſary quality of ſcoria, the colour of which, when freed from the metal, poſſeſſes a conſiderable degree of tranſparency. When a number of theſe iron ſtones are uſed in the blaſt furnace, a much leſs quantity of calcareous earths is neceſſary. It ſometimes happens at iron works, whoſe chief ſupply is derived from a calcareous field of iron ſtone, that, by uſing a great proportion of an individual ore ſurcharged with lime, the operations of the furnace are obſtructed, and conſequences entailed fatal to the intereſt of the manufacturer. From an exceſs of pure calcareous earth being preſent in the furnace, the ſcoria, thick and curdled, becomes attached to the ſides and bottom of the furnace; the quantity hourly increaſes, till it has accumulated to ſuch a degree as to intercept the aſcent of the blaſt,

and the deſcent of the materials. The ſource of this evil is juſtly attributed to the nature of the iron ſtone; but in place of attempting to obviate its imperfections of mixture, it is either totally rejected, or uſed in the moſt ſparing quantities: whereas, had the quantity of calcareous earth been proportioned to that contained in the iron ſtone, the ſame ore might have been advantageouſly ſmelted, and a conſiderable quantity of lime ſaved. The ſame happy effects might alſo have been produced by combining with the calcareous iron ſtone, one containing a large proportion of clay or ſand; in ſome ſituations, where a variety of lime ſtones are found, the ſame conſequences may be effected by applying one leſs pure, mixed with a proportion of clay and ſilex.

A ſimilar exceſs of clay in the argillaceous genus of iron ſtones, is fraught with the ſame fatal effects to the produce in metal from the blaſt furnace; and many ſuch ores of iron are totally rejected, merely becauſe their improper application was found productive of conſequent effects. The fuſibility of lime and clay, individually, is much facilitated by the addition of ſand; and in all caſes where theſe earths exiſt to exceſs in the ores, they ought either to be combined in the blaſt furnace with ſiliceous iron ſtone, or treated with a lime ſtone containing a conſiderable portion of ſand.

Again, inſtances occur in the manufacturing of crude iron, where ores ſufficiently rich in iron are totally rejected, as being incapable of affording a quality of crude iron for the purpoſe of melting. It is found that an exceſs of ſuch iron ſtone always changes the colour of the ſcoria, and that a conſiderable portion of the metal goes to effectuate this change in the ſtate of an oxyde united with the fuſed earths. Theſe ores are of the moſt fuſible nature, combined with a heavy proportion of ſilex; but ſtill capable of being treated in ſuch a manner as to afford their iron of a valuable quality. When this mixture is fully aſcertained, the fuſibility of the iron ſtone is little impaired, and the quality of the iron mended with an increaſe of quantity.

From this it will appear evident, that the addition of calcareous earths, in juſt proportions, will form with moſt ores a vitrid alloy, thinly divided, and to which the metal has ſo little affinity, that it becomes abandoned by the former at an early ſtage of ſeparation, and, being expoſed to the combination of the carbon, is beneficially and richly revived. In this operation lime may be conſidered as introducing into the furnace a conſiderable quantity of carbonic acid, [it is always uſed in the raw ſtate] which becomes decompoſed in ſuch a manner as to furniſh the iron with a ſmall portion of carbonaceous matter. The effects of this extenſion of principle are however much limited, as the carbon afforded by the decompoſition of the carbonic acid can never enable the iron to take up this principle from it in a crude concrete ſtate, capable of conſtituting fuſibility. It may, however, by uniting to it in a neutral ſtate, call it into metallic exiſtence, and enable the carbon afforded by the fuel to diſtribute its fuſible principle over a larger portion of metal. Lime-ſtone therefore ought never to be conſidered as a general ſubſtitute for fuel in the blaſt furnace, though in ſome caſes the effects produced by its application are ſimilar. Its influence extends no farther than to correct the unequal mixtures of ſome ores, and facilitate their ſeparation and carbonation; an improper application of its kind or quantity may be productive of evils of as great magnitude as thoſe it was meant to remove. In no caſe where a juſt proportion of ores and mixtures exiſt in the furnace, and where the reſult from a real ſcarcity of fuel is oxygenated iron, can the addition of lime confer carbonation to the metal.

Theſe facts render the application of lime-ſtone a matter of attention, and not of chance, depending on an accurate knowledge of the component parts of the ores and their effects, and not on certain portions being cuſtomary at works of ſimilar eſtabliſhment. When a ſcarcity of lime exiſts in the blaſt furnace, and a ſuperior quantity of clay

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and ſilex is combined with the iron ſtones, the lava will flow from the furnace comparatively cold, tenacious, and of a brown or pale dirty green colour, containing iron: when the mixture is juſt, the colour of the ſcoria is pure white, enamelled with a variety of blue ſhades, waving, circular, or formed in ſtraight delicate lines, ariſing from a peculiar exiſting modification of a minute portion of the metal. Should lime be added in exceſs, the quality of the iron will not be improved, but the quantity conſiderably diminiſhed. This loſs takes place in two ways; when the iron is oxygenated, the preſence of an extra quantity of fuſed earths facilitates the oxydation of the metal, whenever it comes into contact with atmoſpheric air *. The ſtrong current of air from the diſcharging pipe affords ample opportunity for this oxydation; the ſmall globules of metal deflagrate and become combined with a great portion of oxygen; the want of carbon in the furnace prevents any part of the oxygen from being again removed; the oxydated iron incorporates with

* As I have frequent occaſion to uſe the two verbs, to oxygenate, and to oxydate, I ſhall expreſs the preciſe meaning I attach to two words which are ſometimes indiſcriminately uſed, and to which it has been thought that M. Lavoiſier had affixed no ſeparate or diſtinct meaning. I have uſed oxygenate to expreſs the progreſſive combination of oxygen with the metal, without, however, deſtroying its metallic fracture, or exhibiting internally the ſmalleſt appearance of an oxyde. Oxydation, on the other hand, I have always uſed to expreſs the final conſequence of the combination of oxygen with iron, and the complete change from a metallic ſtate to that of a detached friable oxyde. For example, crude iron run from the furnace, of a white fracture, is ſaid to be oxygenated. In cooling, being expoſed to atmoſpheric air, it acquires a conſiderable quantity of blueiſh oxyde; its ſurface may then juſtly be ſaid to be oxydated. It is the ſame with malleable iron and ſteel; each of theſe ſuffer in quality from the affinity oxygen has to combine with them, at a high temperature, before the leaſt diminution of metallic fracture takes place; and in that ſtate I have always conſidered them as oxygenated. When, however, this was paſt, and the combination of oxygen had deſtroyed every property of metal, I have conſidered this only as a ſtate of oxydation.

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the ſcoria floating upon the ſurface of the precipitated metal, changes its colour, and in iſſuing from the furnace conveys a complete change of form and depoſition.

Should it, however, happen that an extra quantity of lime is added when the iron is already richly carbonated, then the metal loſt is no longer in the ſtate of a fuſed oxyde incorporated with the ſcoria, but in ſmall metallic globules, completely enveloped, unable to penetrate the curdled maſs and find their way to the bottom of the furnace. This curious phenomenon ariſes from the peculiar nature of fuſed calcareous earth, which, while it poſſeſſes no great degree of tenacity as a fluid, yet forms a conſiſtency through which iron with all its ſuperior denſity is not able to penetrate: when cold, ſuch ſcoriæ have no appearance of vitrification, but are of a ſtraw colour, rough fracture, and very ponderous. I have ſome ſpecimens of this ſcoria, obtained from the blaſt furnace, with triple ſtrata of regularly depoſited globules of ſuper-carbonated crude iron, from half an inch to the ſmalleſt diameter.

The ſtrict analogy exiſting betwixt lime ſtones and ores, in the variety and proportions of the earths combined with each, renders the inveſtigation of both equally neceſſary, and requiſite to be performed in connection with each other.

There are advantages to be derived from a thorough knowledge of the component parts of iron ſtones, which may not at firſt ſight ſtrike the manufacturer: where a variety of ſituations offer, this knowledge will direct him to an eſtabliſhment where the iron ſtones are of a nature moſt likely to ſuit his views. Where melting pig iron for ſale is the chief object, calcareous iron ſtones mixed with ſilex and nearly deſtitute of clay poſſeſs the greateſt advantages. Iron made from this claſs of ores never poſſeſſes any great degree of ſtrength; this, however, in the caſting buſineſs in general, is reckoned its greateſt property; it becomes fuſed with leſs fuel, leſs waſte of metal, and the articles made from it exceed thoſe made from ſtronger iron, in the ſmoothneſs of their ſurface and in the ſolidity of their parts.

Analogous to theſe facts, we daily ſee the ſuperiority of ſituation evinced, and *cæteris paribus* larger products in iron obtained from a general uſe of calcareous iron ſtones than any other. This ſuperiority is derived from the congenial mixture of the ore, combined with a large proportion of lime, which facilitates the carbonation of the metal; and united with a juſt portion of ſand to conſtitute fuſibility, the ſame column of blaſt will, in the ſame time, reduce a much greater quantity of it, affording the iron at the ſame time ſufficiently carbonated, than of other iron ſtones differently combined.

On the other hand, where the intention of the manufacturer is to fabricate a quality of iron poſſeſſed of every requiſite for converting into good malleable iron, calcareous iron ſtones, in quantity, ought to be avoided, and thoſe of the argillaceous and ſiliceous claſſes ſubſtituted. Thoſe of equaliſed mixtures of earth, combined with pure argillaceous ores, afford the ſtrongeſt quality of crude iron; capable of being melted to advantage for the conſtruction of heavy pieces of machinery, or uſed for the purpoſes of the forge. In the uſe of theſe claſſes, however, great ſtrength and quantity will be frequently found at variance, when the quality of the metal is wiſhed to be preſerved carbonated: this alſo ariſes from the nature of the mixture in the iron ſtone; clay in quantity, united with various proportions of lime, forms an alloy, more difficult to fuſe than where lime in quantity is united with various proportions of ſilex.

Where nature has beſtowed mixtures productive of every quality of crude iron, the proper arrangement of ores would become ſimple and eaſy; juſt combinations of mixture ſuperſede the neceſſity of changing the quality of the lime ſtone added for a flux, or of having recourſe to various qualities of it, in order to aſſiſt or correct the deficiency of the native mixture. Wherever the ores are of a ſtructure thus deficient, it then becomes the province of the manufacturer to aſcertain the mixture of the individual ores which compoſe his ſupply,

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and to reſtore that equilibrium of parts by the proper application of ſuperadded earths, which experiment and obſervation have proved to determine a certain quality of iron.

Thoſe works whoſe ſituation enables them to draw their ſupply from fields of iron ſtone, impreſſed with all the various characters of mixture, poſſeſs many advantages which thoſe more inſulated are frequently deprived of. With equal eaſe ought the manufacturer to be able in theſe caſes to fabricate with certainty a quality of iron capable of forming to advantage the moſt minute piece of caſting, or the heavieſt piece of ordnance; at pleaſure he might form a quality fit for the forge, or of value in the pig iron market. In ſhort, where ſuch variety of ores exiſt, iron of every quality, compriſing fuſibility and ſtrength, may at pleaſure be manufactured, ſuited to the many and various wants of a foundry and forge.

Failing, however, of this univerſal aſſortment of iron ſtone, nature has in many places kindly formed a competent ſubſtitute, in the great variety and quantity of lime ſtone which are found within eaſy reach of the blaſt furnace, poſſeſſing component parts widely different from each other; from a ſtate of the greateſt purity, to the heavieſt alloy of heterogeneous mixtures; ſometimes ſo far debaſed as not to be juſtly appreciated when ranked under the claſs of lime-ſtones.

A want of analytical knowledge in the manufacturer may often lead to the purchaſe of ſuch qualities as may be ſuperfluous, from the variety of his ores, or which are diametrically oppoſite in quality to thoſe which ought to have been applied. I ſhall here annex the analyſis of the principal lime-ſtones uſed at the Clyde Iron Works, which from their ſuperior ſituation, having eaſy acceſs to the eaſtern or weſtern oceans, can at pleaſure draw their ſupplies from a greater number of quarters than any other work in Britain.

The ſilence of provincial hiſtorians reſpecting the conſtituent parts of various limes is a ſecond inducement to furniſh ſuch a table, which may enable the huſbandman to de-

cide with a juſt preference upon that quality moſt proper for the culture of his grounds. I found chalk to contain carbonic acid and water - - 37·3
Silex and a minute portion of clay - 1·045
Lime - - - 61·655

100 parts.

Iriſh white lime-ſtone.—This beautiful calcareous ſtone is found in various places on the coaſt of Ireland. It greatly reſembles chalk, and differs only from it in its hardneſs, which it derives from a greater quantity of water of cryſtalliſation; it abounds with fine ſpecimens of dog teeth and coxcomb cryſtals; contains a conſiderable quantity of flint in rounded and ovular forms, with very perfect ſpecimens of belemnites. I found this lime-ſtone to contain water of cryſtalliſation and carbonic acid - 44·5
Silex and a minute portion of clay - 3·7
Lime - - - 51·8

100 parts.

Iriſh blue lime-ſtone from Learn.—This ſtone is of a dark blue colour, ſmooth fracture, and ſtudded with ſmall ſhining ſpiculæ; it contains no mixture, or form foreign to itſelf. It contains water of cryſtalliſation and carbonic acid 37·14
Silex - - - 9·43
Lime - - - 53·43

100 parts.

Arran lime-ſtone, from the Iſland of Arran.—This is a reddiſh-coloured lime-ſtone, abounding with ſuch an immenſe quantity of ſhells, that the whole ſtratum, which meaſures 60 feet in thickneſs, appears to have been formed of ſhells connected by means of a calcareous cement much leſs pure; theſe are all univalve, uncommonly large, ſome of them 6 or 8 inches in diameter, and form the pureſt lime. In calcination this ſtone loſes its colour, and becomes as white as ſnow; perhaps a ſmall portion of iron diſſolved in the

the carbonic acid communicates to it the red colour. I found it compounded as follows: water of cryſtallifation and carbonic acid - - - 39·57
Silex - - - - 2·58
Clay - - - - 1·12
Lime - - - - 56·73

100 parts.

Campbletown lime-ſtone on the Argyle coaſt.—This is a very dark blueiſh-coloured lime-ſtone, of a large granulated metallic fracture, hard and refractory; it preſents no ſpecimens of marine remains, but abounds with a common calcareous ſpar, in which regular form is perceptible; when calcined it retains a delicate tinge of blue colour. I found the component parts of this ſtone to be, water of cryſtallifation and carbonic acid - - 41·42
Clay - - - 2·407
Silex - - - 2·92
Lime - - - 53·253

100 parts.

Thornton lime-ſtone, pariſh of Killbryde.—This is a light blueiſh clay-coloured lime-ſtone, ſuſceptible of a fine poliſh, and abounding with a great variety of marine ſhells of various ſizes; the ſchiſtus contains an infinite number of the remains of ſmall fiſhes, ſhells, &c. It yielded water and carbonic acid - - - 43·91
Silex - - - - 4·67
Clay - - - - 5
Lime - - - - 50·92

100 parts.

Creſsbaſket lime-ſtone, ſame pariſh.—This ſtone greatly reſembles the former, but poſſeſſes a greater variety of quality, ſometimes inferior, but contains very few ſhells or marine

remains. The following are its component parts: water of cryſtalliſation and carbonic acid - - 42·9
Clay, with a ſmall tinge of iron - - 3·3
Silex - - - - 2·7
Lime - - - - 51·1

100 parts.

Eaſt-Wood lime-ſtone, from pariſh of the ſame name.—This is a ſharp ſplinty lime-ſtone, of an even fracture, but abounding with ſmall ſpiculæ of ſilex; when expoſed to wet for ſome time its ſurface becomes oxydated like an iron ſtone. It contains a great number of univalve and bivalve ſhells, and marine decompoſition of various kinds. It poſſeſſes not the property of falling into lime, unleſs watered when at a red heat; it then forms a coarſe pulverulent earth, of a greyiſh brown colour. It contains water and carbonic acid 27·42
Clay - - - - 3·73
Iron - - - - 5·83
Silex - - - - 36·66
Lime - - - - 26·36

100 parts.

Lime-ſtone from the neighbourhood of Kirkintulloch.—The appearance of this ſtone is more favourable than the former, though of the ſame inferior caſt; it contains no ſubſtances foreign to itſelf. Its conſtituent parts are, water of cryſtalliſation and carbonic acid - - 37·3
Clay - - - - 12·5
Iron - - - - 3·135
Silex - - - - 8·36
Lime - - - - 38·705

100 parts.

Kylſyth lime-ſtone.—This ſtone is of a dark blue colour, ſmooth fracture, and ſounds like metal when ſtruck upon. It abounds with the fineſt ſpecimens of pure calcareous ſpars, frequently

frequently refolved into tranſparent cryſtals: the chaſms where theſe are found are ſometimes enriched with beautiful priſmatic pyritical cryſtals of a flat ſcaly form. The component parts of this lime-ſtone are as follow:

Water of cryſtalliſation and carbonic acid - -	39·52
Silex - - - -	5·73
Lime - - - -	54·75
	100 parts.

From what has been ſtated, we are led to inquire into the cauſe which produces effects ſo widely different in the fuſibility and ſtrength of crude iron. The exiſtence of calcareous, argillaceous and ſiliceous earths in the blaſt furnace, has been mentioned as effecting theſe changes; and it has been alſo noticed that, under certain mixtures of theſe, determinate qualities of crude iron are produced.

If a predominancy of calcareous earth is uſed as the ſtandard for compariſon, with a local proportion of fuel, we find that in proportion as the lime is diminiſhed in quantity, and clay added through the medium of the ore, the quantity of metal produced will be leſs, but its ſtrength greatly increaſed; and if the argillaceous ores are pure, the carbonation of the metal will be little altered. Should ſiliceous mixtures be applied in place of argillaceous, we find that, in proportion as lime decreaſes, and the quantity of ſand in the furnace is augmented, the quality of the iron becomes leſs carbonated, leſs fuſible, and its ſmall portion of ſtrength greatly impaired: ſand through the medium of the ore may be added, ſo as to render the iron as brittle as glaſs, and as white in the fracture as ſilver.

Again, let a predominancy of ſiliceous earths in the blaſt furnace be the ſtandard for compariſon; in proportion as theſe are diminiſhed by the addition of argillaceous ores, the metal will paſs from the ſtate of extreme brittleneſs and oxygenation, to a ſtate comparatively ſtronger and containing more carbon. Should calcareous iron ſtones be added, their addition will

immediately correct the pernicious effects of the filex, and facilitate the carbonation of the metal; but will not confer any great degree of additional ſtrength. Lime may be added to ſuch exceſs as to render the continuity of the particles of iron ſo ſmall as to be eaſily divided into granulated maſſes, forming a true plumbago.

From a conſideration of theſe reſults, we are led to attribute to calcareous earths the property of facilitating the carbonation of the metal where an improper combination exiſts; which property is derived from the carbon of the acid with which they are neutraliſed. To argillaceous ores we aſcribe ſtrength, without having the tendency of deſtroying the carbon, merely becauſe theſe ores contain a very conſiderable portion of lime; their union counteracts the natural fuſibility impoſed by lime, and at the ſame time is productive of ſtrength. Siliceous iron ſtones are viewed leſs favourably, being nearly deſtitute of lime; the iron in the furnace varies in principle from the development of its mixtures, and only depends upon the quantity of carbon furniſhed by the fuel to become ſaturated with a ſufficiency to conſtitute fuſibility.

The excluſive predominancy of lime and ſilex apart tends in the ſmelting proceſs to reduce crude iron to its two greateſt extremes of quality, carbonation and oxygenation; both of which ſtates are equally deſtitute of ſtrength. Clay acts as the reſtorer of theſe diſproportions, and by a happy combination produces the medium of the two extremes, which is ſtrength and undiminiſhed quality.

Were ſiliceous iron ſtones univerſally combined with a larger portion of oxygen than the other claſſes, another clue would be furniſhed to explain why ſiliceous mixtures were leſs congenial to the exiſtence of carbon in the blaſt furnace, than thoſe of lime and clay; and why the metal obtained from the former is always more oxygenated with the ſame portion of fuel than that obtained from the latter. Although I am convinced that this frequently is the caſe, yet, as I have

not

not been able to assume an extra fixation of oxygen in siliceous iron stones as an universal principle, I would not wish to apply it, in any great degree, to the solution of the present theory, seeing the causes already advanced are sufficient for an explanation of the whole phenomenon.

VIII. *Account of Bugs found in hollow Trees, with Observations on that Phenomenon. By* S. OEDMAN *.

IT is a well known prejudice among the country people in Sweden, that they believe the house bug takes up its residence in the common yellow wall lichen, which grows under the juniper bushes, &c.; but, as far as I have been able to learn, no entomologist ever yet found the real house bug in standing trees, and therefore the following new observation seems to be worthy of attention. Last August some workmen, who were cutting wood on an island in Nämdö Sound, sat down under a hollow alder tree in order to eat their dinner. One of them having accidentally made a noise near the trunk, aroused a bat (*vesp. murinus*), which was immediately seen to fly out from a hole in the side of it. Being desirous to know whether there were any more animals of the same kind in the trunk, these wood-cutters gave it a violent stroke, and a mass was heard to drop, which one of them pulled out with his hand, and found to consist merely of bugs. It is impossible they could be deceived in regard to vermin so well known; and what rendered the circumstance still more certain, was, that they found under the wings of the bat, real bugs, which had taken up their abode there, together with the usual insects that infest these animals. The whole quantity of bugs amounted to about three quarts. M. Blix, who was at great pains to examine this phenomenon more narrowly, found in the bottom of the

* From New Transactions of the Academy of Sciences at Stockholm, vol. x.

hollow

hollow tree two concave places filled with ſtraw and ſoft earth, in which the bats probably kept their young; for the old ones when they ſleep generally ſuſpend themſelves by the hooks of their wings. Some time after, M. Blix having heard that a bat had been ſeen to fly into a hollow tree on the iſland where he reſided, repaired to the place, and drove from the tree thirty-ſeven bats. It accidentally came into his head to examine with a ſtick the roof of their dwelling; and when he drew out the ſtick he obſerved the end of it covered with bugs. He made no farther examination till a few days before Chriſtmas, when the tree was felled; but at this time neither bats nor bugs were to be ſeen. He, however, diſcovered that this tree had lodged gueſts of various deſcriptions; for the lower part had been inhabited by bats; the roof of the cavity by bugs; the middle by nut-peckers, and the top of the tree by a ſquirrel. It is not altogether improbable that the bugs had been carried thither from ſome habitation by the bats, eſpecially as they were found, in the firſt caſe, on an iſland totally ſeparated from the continent, and on which there was not a ſingle houſe. It is more difficult to explain how ſuch a multitude of bugs could find nouriſhment on two or three dozen of bats; but inſtances have been known of ſtone buildings infeſted with ſuch vermin, remaining above a year uninhabited, and yet theſe inſects, ſo far from being extirpated, have not even been leſſened. We can ſcarcely then give any other explanation, than by ſuppoſing that bugs eat each other when they have no other nouriſhment; and that the loſs thence occaſioned is ſupplied by their great multiplication. The cauſe why no bugs were found when the laſt mentioned tree was felled, may have been, that they were deſtroyed by the birds. In confirmation of the above, M. Carlſon adds the following circumſtance: "In the year 1777," ſays he, "I found an old rotten ſtake, that had been uſed for a ſupport in a hedge, which was ſo covered with houſe bugs that it reſembled an ant-hill: it lay at a great diſtance from either houſes or gardens,

dens. I inquired whether this ſtake had, at any time, formed part of a building, or been near one; but I was aſſured by a peaſant that he had cut it down not far from the ſpot, and that it had never been employed for any other purpoſe. As this ſtake was not hollow, and could afford no ſhelter to bats, it does not appear how theſe bugs could be conveyed to it from a houſe. There is reaſon to conjecture, rather, that theſe inſects live and propagate even in timber. That they are able to endure the winter cold is beyond all doubt. I expoſed a piece of furniture to the open air for three years, and every ſummer bugs were obſerved upon it in great abundance.

IX. *Obſervations on Animal Electricity; being the Subſtance of two Letters from* A. Volta *to Profeſſor* Gren *.

If a tin baſon be filled with ſoap-ſuds, lime-water, or a ſtrong ley, which is ſtill better, and if you then lay hold of the baſon with both your hands, having firſt moiſtened them with pure water, and apply the tip of your tongue to the fluid in the baſon, you will immediately be ſenſible of an acid taſte upon your tongue, which is in contact with the alkaline liquor. This taſte is very perceptible, and, for the moment, pretty ſtrong; but it is changed afterwards into a different one, leſs acid but more ſaline and pungent, until it at laſt becomes alkaline and ſharp in proportion as the fluid acts more upon the tongue, and as the activity of its peculiar taſte and its chemical power, more called forth, produce a greater effect in regard to the ſenſation of acidity occaſioned by the ſtream of the electric fluid, which, by a continued circulation, paſſes from the tin to the alkaline liquor, thence to the tongue, then through the perſon to the water, and thence to the tin again. I explain the phenomenon in this

* From *Neues Journal der Phyſik*, vol. iii. p. 4, and vol. iv. p. 1.

manner,

manner, according to my principles; and indeed it cannot be explained in any other, as every thing tends to confirm my aſſertion, and to prove it in various ways. The contact of different conductors, particularly the metallic, including pyrites and other minerals as well as charcoal, which I call dry conductors, or of the *firſt claſs*, with moiſt conductors, or conductors of the *ſecond claſs*, agitates or diſturbs the electric fluid, or gives it a certain impulſe. Do not aſk in what manner: it is enough that it is a principle, and a general principle. This impulſe, whether produced by attraction or any other force, is different or unlike, both in regard to the different metals and to the different moiſt conductors, ſo that the direction, or at leaſt the power, with which the electric fluid is impelled or excited, is different when the conductor A is applied to the conductor B, and to another C. In a perfect circle of conductors, where either one of the ſecond claſs is placed between two different from each other of the firſt claſs, or, contrariwiſe, one of the firſt claſs is placed between two of the ſecond claſs different from each other, an electric ſtream is occaſioned by the predominating force either to the right or to the left—a circulation of this fluid, which ceaſes only when the circle is broken, and which is renewed when the circle is again rendered complete. This method of connecting the different conductors will be more readily comprehended by turning to the figures, (plate I,) where the capital letters denote the different conductors or exciters *(moteurs)* of the firſt claſs, and the ſmall letters thoſe of the ſecond claſs. Fig. 1 and 2 expreſs the two caſes above mentioned.

I conſider it as almoſt ſuperfluous to obſerve, that when the circle conſiſts merely of two kinds of conductors, however different or however numerous the pieces may be of which each conſiſts (as fig. 3, 4, 5 and 6), two equal powers are oppoſed to each other; that is, the electric fluid is impelled with equal force in two different directions, and conſequently

no

no ſtream can be formed from right to left, or contrariwiſe, capable of exciting convulſive movements.

There are other caſes, however, and other modes of combination, where the powers are equally in equilibrium, and where no current of the electric fluid can take place; or, at leaſt, none of ſuch a force as to make an impreſſion on the tendereſt nerves, or to excite any convulſive movement in the beſt prepared frog that may be placed in the circle, notwithſtanding the intervention of two or more different kinds of metals. This is the caſe when each of theſe metals is placed between two moiſt conductors, or of the ſecond claſs, and which are very nearly of the ſame kind, as fig. 7; or when, in a circle of three pieces, two of them of the ſame metal, and one of a different metal, are ſo connected, that the latter is immediately between the other two, as fig. 8.

When one of the ends of the middle piece of metal A is immediately applied to one of the two pieces Z, but, inſtead of immediately touching with the other end, the other piece Z touches an intermediate conductor of the ſecond claſs, either great or ſmall, either a drop of water, a piece of raw or boiled fleſh, or of ſponge not moiſt, paſte of meal, jelly, ſoap, cheeſe, or the white of an egg boiled to hardneſs, in this new combination, repreſented by fig. 9, (where a conductor of the ſecond claſs *m* is between two of the firſt claſs, A and Z) the powers are no longer oppoſed to each other; and this is ſufficient to determine an electric ſtream. When *g*, therefore, in fig. 9, is a prepared frog, it will always be violently agitated as often as this circle is made complete.

It may be readily perceived that the two laſt experiments, repreſented by fig. 8 and 9, coincide with thoſe announced by M. Humboldt, where a drop of water, a ſmall bit of freſh meat, or a very thin ſtratum of any fluid, performs the whole wonder. When another drop of water, or any other aqueous conductor, is applied betwen the other end of A and the other correſponding piece Z (as ſhewn fig. 10), each piece of metal is inſulated, as I ſhall expreſs it, between two aqueous

aqueous conductors: but then the powers from right to left, and from left to right, are again completely oppoſed to each other; conſequently the electric ſtream is impeded, and the frog remains without any movement. It is, therefore, abſolutely neceſſary that two different metals or conductors of the firſt claſs ſhould be in immediate contact with each other, on the one ſide, while with their oppoſite ends they touch conductors of the ſecond claſs.

We might conſider this mutual contact of two different metals as the immediate cauſe which puts the electric fluid in motion, inſtead of aſcribing that power to the contact of the two metals with the moiſt conductors. Thus, for example, in fig. 1, inſtead of admitting two different actions, at leaſt, in regard to the magnitude of the power, one where A comes in contact with *a*, and another where Z comes in contact with *a* alſo, by which an electric current ariſes in the direction from Z to A, we might ſuppoſe only one action at the point where A comes in contact with Z, which impells the fluid in that direction. In both ſuppoſitions the reſult, as may be eaſily ſeen, is the ſame. But though I have reaſons for adopting the firſt as true rather than the ſecond, yet the latter repreſents the propoſition with more ſimplicity, and it may be convenient to adhere to it in the explanation, as it affords a readier view of it. We may then ſay, that in the caſes of fig. 3, 4, 5, 6, 7 and 10, no effect will be produced, becauſe here there is no mutual contact of different metals: that the effect alſo, according to fig. 8, will be null, becauſe A, on two oppoſite ſides, is in contact with Z and Z, and the actions therefore are in equilibrium; and laſtly, that an electric current will be occaſioned in fig. 9, by the action which ariſes from the contact of A and Z, and which is counteracted by no other contact of the like kind.

Having ſeen the reſult of employing three pieces of metal, or conductors of the firſt claſs, viz. two of one kind and one of a different, when combined ſometimes in one way and ſometimes in another with conductors of the ſecond claſs,

we ſhall now try what will be the reſult, according to my principles, with four pieces of metal, two of which are of one kind; for example, zinc, when connected with moiſt conductors of different kinds.

I ſhall firſt obſerve, that when they are connected in a circle, as at fig. 11, the powers which endeavour to put the electric fluid in a ſtreaming movement will be oppoſed to each other, and in perfect equilibrium, and that conſequently no movement can take place in the frog, here ſuppoſed to be the moiſt conductor *a* or a part of it, however irritable and well prepared it may be; and if the experiment be made with accuracy and the neceſſary precaution, ſo that the metals, in particular, be very clean and dry at the points of contact, it will perfectly confirm what I have above ſaid: the frog will experience no agitation, no convulſive movement.

Theſe movements, on the other hand, took place, as might be foreſeen from my principles, as often as I omitted one of the middle pieces, or changed the order.

The conductors of the ſecond claſs, which in all the figures are denoted by ſmall letters, may be cups with water, in which the ends of the pieces of metal denoted by the large letters are immerſed; or ſponges or other bodies which have imbibed aqueous moiſture. They may be either large or ſmall; and may conſiſt of one or more pieces, provided they be in proper contact: they may alſo be perſons, if their ſkin be moiſtened at the places of contact, &c. By the laſt method the experiments will be very beautiful and inceſſant, when the circle conſiſts of three or more perſons (I have formed it frequently of ten and even more), of two or more frogs properly prepared, and of four pieces of metal, two of ſilver and two of iron, tin, and particularly zinc. The change of effect, when you change the connection, is ſtriking.

Let the poſition be as repreſented in fig. 12, where *g* is the prepared frog, which the two perſons *p*, *p*, hold in their hands, one on the one ſide by the feet, and the other on the oppoſite by the rump. Z, Z are two plates of zinc, which

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are held alſo by theſe perſons, and A, A, two pieces of ſilver, which are held by a third perſon, denoted alſo by *p*. It muſt not be forgotten that the hands ſhould be very moiſt, as the dry ſkin is not a conductor ſufficiently ſtrong. As in this chain the actions of the electric exciters are oppoſed to each other and in exact equilibrium, as may be readily perceived, no convulſion or agitation in the frog will take place.

Now, let one of the metallic pieces A, Z, which ſtand between the two perſons *p*, *p*, or between any other moiſt conductors, be left in combination as it is; and let the poſition of the two other metallic pieces A, Z, be reverſed, by converting fig. 12 into fig. 13 (ſo that the actions, inſtead of being contrary, will act together to impel the electric fluid to one ſide or to produce the ſame current); or introduce between A and Z another perſon, or any other conductor of the ſecond claſs, ſo that the chain be formed as in fig. 14; or take away one of the pieces A, Z, in fig. 12, and make the chain like thoſe of fig. 15 and 17; or, in the laſt place, remove the whole two pieces A, Z, either in the one or the other ſide, as repreſented fig. 17 (by which means it will correſpond with fig. 1, as the whole chain *p*, *g*, *p*, *p*, may be conſidered as a ſingle moiſt conductor of the ſecond claſs); in all theſe combinations, which are repreſented by fig. 13, 14, 15, 16, and 17, the actions ariſing from the metallic contacts are no longer contrary to each other, or in equilibrium, as they were in fig. 12; conſequently an electric ſtream is produced, and the frog *g*, which I ſuppoſe to be properly prepared, and which forms a part of the chain, will be violently agitated as often as the circle, when broken at any one place, particularly between metal and metal, is again reſtored.

In regard to the experiment where a moiſt conductor, or one of the ſecond claſs, is to be introduced between the two pieces A, Z (fig. 14), that is, between two different metals, a drop of water, or a ſmall bit of moiſtened ſponge, or a thin ſtratum of any fluid, ſoap, or any other viſcous matter, will be quite ſufficient, as I have already obſerved reſpecting fig. 9.

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This ſurpriſing experiment I generally make in ſuch a manner, that, inſtead of the piece of metal, I employ a cup or ſpoon filled with water, and then cauſe the perſon who holds the perfectly dry and pure ſtick of tin to touch with that ſtick ſometimes the perfectly dry ſides of the ſpoon or cup, and ſometimes the water contained in them. It is wonderful to ſee, that as by the latter method the violent agitation of the frog never ceaſes, the firſt method, which correſponds with fig. 12, does not produce the leaſt irritation; unleſs by accident there be a ſmall drop of water, or a thin ſtratum of moiſture, at the place of contact, by which the caſe repreſented fig. 14 would be reſtored. This may ſerve to ſhew with what care and attention the experiment muſt be made, in order to guard againſt error or deception, which might ſo eaſily ariſe, and every where exhibit anomalies.

When I introduce water or any other moiſt body, great or ſmall, not merely between one pair of metallic pieces A, Z, as fig. 14, but between two pairs, as repreſented fig. 18, each piece of metal is between like moiſt conductors, and by theſe means all the actions are again rendered contrary or brought into equilibrium; or, according to the other mode of viewing the matter, there is no longer any action, for want of the mutual contact of two different metals, which, as we have ſeen, is certainly neceſſary to excite an electric current; and it is always found that the frog experiences no agitation.

I ſhall not enlarge farther on theſe combinations, which may be varied ad infinitum with a greater number of metallic pieces, and by which one may be enabled to foretel the phenomena which, according to my principles, will always be found to take place. It will be ſufficient, for the preſent, to draw this concluſion, that in a circle conſiſting merely of two conductors, however different they may be, their mutual contact can produce no electric ſtream ſufficient to excite ſenſibility or muſcular movement; and that, on the contrary, this effect infallibly follows as often as the chain is

formed of three conductors, one of one clafs, and two different from each other of another clafs, which come into mutual contact with each other, and that this effect will be ſtronger the greater the difference is between the latter; that in other caſes, where there are more than three different conductors, the effect either is not produced or will be produced in different degrees, according as the forces, called forth by the different combinations, which will be expanded at each heterogeneous contact, and which are often in oppoſition and endeavour to impel the electric fluid in oppoſite directions, are perfectly in equilibrium with each other, (which muſt be a very rare caſe) or when the ſum of thoſe which exert themſelves in one direction is more or leſs exceeded by the ſum of thoſe which act in another direction.

I ſhall here however leave the two complex combinations, and return to the ſimple caſes, thoſe with three different conductors, repreſented by fig. 1, which are more demonſtrative; or, in other words, thoſe with two different metals or conductors of the firſt clafs which are in contact with each other, and are applied on the other ſide to moiſt conductors or conductors of the ſecond clafs. This method has been commonly employed ſince Galvani's diſcovery, and is in exact proportion with the diverſity of metals on which I conſider the whole phenomena to depend.

The other method of combination, which is expreſſed by fig. 2, or that of a metal placed between two different moiſt conductors, for example, between water on the one ſide, and an aqueous, ſaponaceous, or ſaline fluid on the other, I diſcovered in the autumn of 1794; and though ſince that period I have repeated the much varied experiments of different perſons, both foreigners and others, among which was that of M. Humboldt, and though I wrote to ſeveral correſpondents reſpecting it, that light has not yet been thrown on this new phenomenon which it ſeems to deſerve.

The ſingular circumſtance before mentioned, in regard to the acid taſte when the tongue is brought into contact with

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an alkaline liquid, belongs, as you may perceive, to this fecond method of exciting the electric fluid and putting it in circulation (if the tin veffel be touched on the outfide by the hand moiftened with water, and on the infide by the alkaline liquor), and fhews that this current is no lefs ftrong and active than that excited by the firft method, viz. by employing two fufficiently well chofen metals, fuch as lead and copper, iron and filver, zinc and tin. I muft here obferve, that though with tin alone, placed between water and an alkaline liquor, you obtain nearly the effect which is produced by two of the moft different metals, as filver and zinc, combined with any conductor whatever of the fecond clafs; you can obtain the fame, and even in a higher degree, with iron alone or filver alone, when the iron is introduced between water on the one fide and nitrous acid on the other, or when the filver is applied between water and a folution of fulphure of pot-afh.

If you take a frog, the head of which has been cut off, and which has been deprived of all life by thrufting a needle into the fpinal marrow, and immerfe it, without fkinning it, taking out the bowels, or any other preparation, into two glaffes of water, the rump into one, and the leg into the other as ufual, it will be ftrongly agitated and violently convulfed when you connect the water in both glaffes by a bow formed of two very different metals, fuch as filver and tin or lead, or, what is better, filver and zinc; but this will by no means be the cafe when the two metals are lefs different in regard to their powers, fuch as gold and filver, filver and copper, copper and iron, tin and lead. But what is more, the effect will be fully produced on this fo little prepared frog when you immerfe in one of the two glaffes the end of a bow merely of tin or zinc, and into the other glafs the other end of this bow which has been rubbed over with a little alkali. You may perform the experiment ftill better with an iron bow, one end of which has been covered with a

drop or thin coating of nitrous acid; and beyond all expectation, when you take a silver bow having a little sulphure of pot-ash adhering to the end of it.

Fig. 19 represents the form of this experiment, where *g* is the frog, *a*, *a* the two glasses with water, A the bow formed of one single metal, and *m* the drop or a thin stratum of a mucous, saline, &c. fluid with which the bow has been rubbed over, and which on this side is between the metal and the water.

[To be continued.]

X. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth. By* M. DE SAUSSURE*.

[Continued from page 299 of Vol. III.]

CHAP. XV.

Observations to be made on primitive Mountains.

1. WHETHER there be any exception to the generally received opinion, that, in primitive mountains, no vestiges are discovered of organised bodies.

2. Whether it be true that in these mountains no indications are found of bitumen or marine salt.

3. To endeavour to determine the respective ages of the different kinds of primitive mountains; both compound, such as granite, porphyry, gneiss; and simple, as slate, serpentine, and primitive calcareous.

4. Whether, in particular, it be certain that granite is the most ancient stone of all those which form the outer crust of our globe, so that it is never found placed above (*superposé*) any other kind of stone.

* From Journal des Mines, No. XX.

5. Whether

5. Whether the large mountains compoſed of granite in one maſs, even the beſt characteriſed, do not give certain indications of ſtratification or diviſions by ſtrata, though leſs regular than thoſe of ſchiſtous mountains.

6. Whether in the baſes of granite mountains the manifeſtation of ſtrata be not hurt by the number of fiſſures, or ſpontaneous and irregular diviſions.

7. Whether, even in the ſeparate blocks of granite, an attentive eye does not diſcover ſome veins of mica, which affect the ſame direction, and ſuch veins as induce the workmen, who wiſh to make mill-ſtones or other works more extenſive in one direction than another, to prefer attacking the ſtone in a determined direction.

8. Whether the indications of the ſtratification are not obſerved in the interior part of granite mountains, as well as near their ſurface.

8. A. Whether among the granites in a maſs, and thoſe decidedly veined, there are not found ſuch intermediary ſhades that it is difficult to mark the line of ſeparation.

9. To determine the diſtinguiſhing characters of granites of modern formation.

11. To aſcertain the truth of the aſſertion of the Pliny of France, that in proportion as people dig into a mountain, the ſummit and ſides of which conſiſt of granite, the granites, inſtead of being found more ſolid and more beautiful the farther they advance, change, on the contrary, below a certain depth, loſe themſelves, and at laſt vaniſh by gradually aſſuming the coarſe (*brute*) nature of the live quartzy rock*.

12. Whether it be true that each primitive mountain is generally compoſed of one ſingle ſtone, and of the ſame nature.

13. To examine whether there be found on the primitive mountains, at great heights, the ſcattered wrecks of ſecondary mountains. For my part, I never found any.

14. Whether primitive calcareous ſtone be found always

* Mineraux, p. 105.

with a granulated fracture, or the form of a faline marble, and never under a compact form.

15. Ought the porphyric fchift of Werner, or the *porphyre fchifteux à pate* of primitive petro-filex, to be confidered as primitive or fecondary? The fame queftion in regard to the *mandelftein* or amygdaloid.

16. Is it fully afcertained, as I thought I obferved in the Alps, and M. de Fichtel in the Carpathian mountains, that there exifts pudding-ftone or free-ftone, if not primitive, at leaft of a formation anterior to that of all the other fecondary ftones?

17. Were the granites in a mafs firft depofited, becaufe they were lefs foluble? and did they cryftallife after the quantity or diffolving force of the waters began to diminifh? and was it for a contrary reafon that the gneifs, mica and magnefian ftones cryftallifed later?

CHAP. XVI.

Obfervations to be made on Tranfitions.

1. To obferve the intermediary genera and fpecies of foffils, between one genus or one fpecies of foffil, and the genera and fpecies which have the greateft refemblance to them.

2. To obferve, above all, the tranfitions through which nature has paffed, when, having produced one genus or one order of mountains, fhe began to produce a different genus or order: for there is no change of order which has not been the effect of a revolution; and it is in the tranfitions that traces of thefe revolutions are to be found.

3. Thus we often fee ftrata of free-ftone or pudding-ftone interpofed between the primitive and fecondary mountains; *breches* are feen to form the moft elevated ftratum, and confequently the neweft of fome calcareous mountains. We muft ftudy then the nature, dimenfions and pofition of thefe remarkable ftrata.

4. Having

4. Having found these transitions, or any others, in some mountains, if they are not then found in other mountains, you must examine whether their absence does not arise from their having been destroyed; vestiges of them are to be sought for; and if it appears that they never existed, you must endeavour to discover, in the nature and position of the mountains, what may have been the cause of their absence*.

[To be continued.]

XI. *Observations on the Manufacture of the Acetite of Copper or Verdigrise, Verdet, &c.* *By* J. A. Chaptal.†

THE acetite of copper is one of the preparations of that metal most frequently used in the arts. It is not only one of the principal resources of painting, but upon many occasions is employed with great advantage in dyeing. Almost all the oxydes of copper obtained by the action of saline substances have a blue colour, more or less inclining to green, and almost all the neutral salts corrode the metal, and produce that oxyde which is called verdigrise. It is sufficient to bring them into contact with the copper, or to immerse the metallic plates in a saline solution, and afterwards to expose them to the air to dry.

Those acids which oxydate the copper by their decomposition, produce an effect like that of neutral salts. The oxyde is of a soft blueish-green colour; their action is so speedy, that if the copper be exposed to the vapour of them for some minutes its surface will be immediately oxydated. The oxygenated muriatic acid produces that effect as well as the vapour of the nitric acid, and even those of the sulphuric acid. A phenomenon which cannot escape the eye of an

* The best method of observing mountains, in order to acquire a thorough knowledge of them, is, not to confine oneself merely to follow the valleys, but to intersect also, as much as possible, the principal chains and the branches detached from them in the direction of their breadth. C.

† From Annales de Chimie, No. LXXV.

obſerver, is, that the oxydes of copper obtained by fire are very different from thoſe produced by the decompoſition of acids on that metal. The colour of them is grey, inſtead of being green; and when the calcination is continued a long time at a violent heat, they may be concentrated to a red oxyde of a blood colour. This phenomenon was obſerved by Kunckel in his chemical laboratory.

Saline ſubſtances are not the only ones capable of oxydating copper green. All oils and fat matters produce the ſame effect. Even water, when left for a conſiderable time in copper veſſels, cauſes an oxydation. But what will appear very extraordinary is, that the greater part of theſe ſubſtances have no ſenſible effect upon copper, except when cold. Thoſe ſalts even which corrode that metal when left at reſt in veſſels, do not attack it in ſo ſenſible a manner when in a ſtate of ebullition.

Of all the preparations of copper by oxydation, there is none more valuable than that made by vinegar. All the verdigriſe uſed in commerce is prepared by that acid, and it is at Montpellier in particular and in the neighbourhood, that the manufactories of it are eſtabliſhed. In the Memoirs of the Academy of Paris for 1750 and 1753, may be ſeen a very exact deſcription of the proceſs then followed at Montpellier for making verdigriſe; but as that proceſs has been much improved, and as at preſent the huſks of grapes are employed inſtead of the ſtalks, a method far more economical, ſince wine is no longer uſed, the following account of the manner of manufacturing verdigriſe, as now practiſed, may be of utility to the public.

The firſt materials uſed for this purpoſe are copper and the huſks or ſkins of grapes left after the laſt preſſing. The copper employed was formerly all imported from Sweden; but at preſent it is brought from different foundries eſtabliſhed at Saint Bel, Lyons, Avignon, Bedarieux, Montpellier, &c. It is in round plates half a line in thickneſs, and from twenty to twenty-five inches in diameter. Each plate at

Montpellier

Montpellier is divided into twenty-five laminæ, forming almoſt all oblong ſquares of from four to ſix inches in length, three in breadth, and weighing about four ounces. They are beat ſeparately with the hammer on an anvil to ſmooth their ſurfaces, and to give the copper the neceſſary conſiſtence. Without this precaution it would exfoliate, and it would be more difficult to ſcrape the ſurface in order to detach the oxydated cruſt. Beſides this, ſcales of pure metal would be taken off, which would haſten the conſumption of the copper.

The huſks of grapes, known at Montpellier under the name of *racque*, were formerly thrown on the dung-hill after the poultry had picked out the ſmall ſtones contained in them. At preſent they are preſerved for making verdigriſe, and ſold at the rate of from fifteen to twenty livres per *muid*. The preparation of them is as follows: After the vintage is finiſhed, the huſks are ſubjected to the preſs, in order to extract all the wine with which they may be impregnated, and they are then put into vats, where they are preſſed down with the feet to fill up all the vacuities and render the maſs as compact as poſſible. The coverings of theſe vats are carefully faſtened down, and they are preſerved for uſe in a dry cool place.

Theſe huſks are not always of the ſame quality: when the grapes contain little of the ſaccharine matter, when the ſeaſon has been rainy, the fermentation incomplete, or when the wine is not generous, the huſks are attended with ſeveral faults. 1. They are difficult to be preſerved, and there is great danger of their ſoon being ſpoilt. 2. They produce very little effect, cannot be eaſily heated, ſend forth very little of the acetous odour, and make the plates of copper ſweat without ſhewing efflorescence on their ſurface. Independently of the nature of the grapes and the ſtate of the wine, the quality of the huſks varies alſo according as they have been expreſſed with more or leſs care. Huſks which have not been much preſſed, produce a far greater effect than thoſe which have been dried. To explain their different effects,

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it will be ſufficient to obſerve that their action is proportioned to the quantity of wine they retain, as it is that liquor alone which can paſs to the ſtate of vinegar. When the huſks therefore are deſtined for a verdigriſe manufactory, care muſt be taken to expreſs them only weakly, in order to preſerve more of their acidifiable principle.

When a ſufficient quantity of copper and of huſks has been provided, nothing remains but to proceed to the operations, which are generally performed in cellars. They may be performed alſo on a ground floor if it be ſomewhat damp, if the temperature be ſubject to little variation, and if there be not too much light. The firſt operation is to make the huſks ferment, which is called *æstus*. For that purpoſe one of the vats is opened, and the huſks are put into two others of equal ſize, taking care to expoſe them as little as poſſible to the air, and not to compreſs them. One vat full of huſks ought to fill two, and to occupy a double ſpace after this operation. In ſome manufactories the huſks contained in a vat are diſtributed into twenty or twenty-five earthen veſſels or jars called *ouls*, and which are generally ſixteen inches in height, fourteen in diameter at the belly, and about twelve at the mouth. When the huſks have been put into theſe veſſels, they are covered by putting the lid merely on the opening without preſſing it down. The covers are of ſtraw, and made for that purpoſe. In this ſtate the huſks ſoon heat; and this change may be known by thruſting the hand into them, and by the ſour ſmell which they begin to exhale. The fermentation firſt takes place at the bottom of the veſſel, and gradually aſcending extends itſelf to the whole maſs. It proceeds to 30 or 35 degrees of Reaumur.

At the end of three or four days the heat decreaſes, and at length ceaſes entirely; and as the manufacturers apprehend the loſs of a portion of the vinegar by the natural effect of a heat too much prolonged, they take care after three days fermentation to remove the huſks from the fermenting veſſels, in order that they may ſooner cool. Thoſe who employ vats

remove

remove them into jars, and thofe who ufe jars put them into others. Befides the lofs of the acetous fpirit, too great heat inclines the mafs at the bottom of the veffel to become mouldy, which renders it unfit for making verdigrife. Some manufacturers, to increafe the effect of the hufks, form them into heaps, which they befprinkle with generous wine before they bring them to ferment.

The fermentation does not always take place at the fame time, nor with the fame energy. Sometimes it commences in twenty-four hours, and fometimes it has not begun at the end of three weeks. The heat fometimes will rife to fuch a height that the hand cannot be kept in the mafs, and that the acetous odour is fo ftrong that one can hardly approach the veffels; while at others the heat is hardly fenfible, and foon vanifhes. There are even inftances of the hufks becoming putrid and mouldy without turning acid. The fermentation is affifted and promoted by raifing the heat of the place by means of chafing-difhes, by covering the veffels with cloths, by fhutting the doors, and by airing the mafs with more care. The differences in the fermentation depend, 1. On the temperature of the air: in fummer the fermentation is fpeedier. 2. On the nature of the hufks: thofe which arife from very faccharine grapes heat more eafily. 3. On the volume of the mafs: a larger mafs ferments fooner, and with more ftrength, than a fmall one. 4. On the contact of the air: the beft aired hufks ferment beft.

At the fame time that the hufks are made to ferment, a preliminary preparation called *defafouga* is given to the plates of copper which are ufed for the firft time. This operation is not employed for thofe which have been already ufed, and confifts in diffolving verdigrife in water in an earthen veffel, and rubbing over each plate with a piece of coarfe linen dipped in this folution. The plates are then immediately placed clofe to each other, and left in that manner to dry. Sometimes the plates are only laid on the top

top of the fermented huſks, or placed under thoſe which have been already uſed for cauſing the copper to oxydate. It has been obſerved, that when the operation called *deſafouga* has not been employed, the plates grow black at the firſt operation, inſtead of becoming green.

When the plates are thus prepared, and the huſks have been brought to ferment, the workmen try whether the latter are proper for the proceſs, by placing under them a plate of copper, and leaving it buried there for twenty-four hours. If the plate of copper, after this period, is found covered with a ſmooth green cruſt, in ſuch a manner that none of the metal appears, they are then thought fit for being diſpoſed in layers with the copper. On the other hand, if drops of water are obſerved on the ſurface of the plates, the plates are ſaid to *ſweat*, and it is concluded that the heat of the huſks has not ſufficiently ſubſided. They conſequently defer making another trial till the next day. When they are aſſured that the huſks are in a proper ſtate, they form them into layers in the following manner:

The plates are all put into a box, which, inſtead of having a bottom, is divided in the middle by a wooden grate. The plates diſpoſed on this grate are ſo ſtrongly heated by a chafing-diſh placed under them, that the woman employed in this labour is ſometimes obliged to take them up with a cloth, in order that ſhe may not burn her hands. As ſoon as they have acquired that heat, they are put into the jars in layers with the huſks. Each jar is then cloſed with a covering of ſtraw, and left to oxydate. This period is called *coüa*, to hatch. Thirty or forty pounds of copper, more or leſs according to the thickneſs of the plates, are put into each jar. At the end of ten, twelve, fifteen, or twenty days, the jar is opened; and if the huſks are white, it is time to take out the plates. The cryſtals are then ſeen detached, and of a ſilky appearance on their ſurface. The huſks are thrown back, and the plates are put in what is called *relai*. For that purpoſe

poſe they are immediately depoſited in a corner of the cellar on ſticks ranged on the floor. They are placed in an upright poſition, one leaning againſt the other; and at the end of two or three days they are moiſtened, by taking them up in handfulls and immerſing them in water in earthen pans. They are depoſited quite wet in their former poſition, and left there for ſeven or eight days; after which they are once or twice immerſed again. This immerſion and drying are renewed ſix or eight times, every ſeven or eight days. As the plates formerly were put into wine, theſe immerſions were called *one wine*, *two wines*, *three wines*, according to the number of times. By this proceſs the plates ſwell up, the green is nouriſhed, and a coat of verdigriſe is formed on all their ſurfaces, which may be eaſily detached by ſcraping them with a knife.

Each jar furniſhes five or ſix pounds of verdigriſe at each operation. It is then called freſh verdigriſe, moiſt verdigriſe, &c. This verdigriſe is ſold in that ſtate by the manufacturers to people who dry it for foreign exportation. In this firſt ſtate it is only a paſte, which is carefully pounded in large wooden troughs, and then put into bags of white leather, a foot in height and ten inches in diameter. Theſe bags are expoſed to the air or the ſun, and are left in that ſtate till the verdigriſe has acquired the proper degree of dryneſs. By this operation it decreaſes about fifty per cent., more or leſs according to its primitive ſtate. It is ſaid to ſtand proof by the knife, when the point of that inſtrument puſhed againſt a cake of verdigriſe through the ſkin cannot penetrate it.

The plates of copper which have been already uſed are again employed for the ſame operation, till they are almoſt completely conſumed. Inſtead of heating them artificially, as above mentioned, they are ſometimes expoſed only to the ſun. The ſame plates will ſerve ſometimes for ten years, but they are often worn out in two or three. This, however,

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depends on the quality of the copper. That which is extremely smooth, well beat, and very compact, is always most esteemed.

Formerly moist verdigrise could not be sold till its quality had been previously ascertained; and for that purpose it was carried to a public warehouse, where it was sold after that point had been determined.

By comparing this process with that described by Montet, it will be found that the changes introduced are much in favour of the new. Formerly the workmen took the stalks of the grapes dried in the sun, and began by immersing them for eight days in *vinasse* (the residuum of the distillation of wine for making brandy). They then suffered the moisture to drain off through a basket, after which they put about four pounds into a jar, and poured over them three or four pints of wine. The stalks were made to imbibe a large portion of the wine, by stirring them strongly with the hand; the jar was then covered, and the stalks were suffered to ferment. The fermentation commenced sooner or later, according to the nature of the wine and the temperature of the air. But after it had once begun, the wine became turbid, and exhaled a strong odour of vinegar. At length the heat decreased, and the stalks were then taken out and the wine was drawn off. When the stalks were a little drained, they were disposed in layers with the plates of copper, and the operation was continued in the same manner as with the husks. When the plates were taken from the jars to be put in *relai*, instead of immersing them in pure water, as is done at present, they were moistened three or four times with four wine, which was called giving them three or four wines.

It may be easily seen that there is a great saving in the process followed at present, since the manufacturers no longer use wine, which enhanced the price of the verdigrise. Some have condemned, in the new process, the practice of using the copper too soon; but this objection fell to the ground, when

when it was obſerved that the verdigriſe obtained was in proportion to the copper corroded; and what proves that this method is more advantageous, is, that all the manufacturers have abandoned the old method and adopted the new *.

XII. *On the Method of preparing Tallow Candles with Wooden Wicks. By Profeſſor* MEDICUS *of Heidelberg*†.

"FOR ſeveral years paſt tallow candles with wooden wicks have been prepared, in large quantities, by the candle-makers at Munich, and much uſed in that neighbourhood. I have burnt them during the whole winter, and never wiſh to uſe any other kind, as they are attended with ſeveral advantages which common tallow candles do not poſſeſs. They afford about the ſame quantity of light as a wax candle; burn alſo with great ſteadineſs and uniformity, and never crackle or run. The candle-makers here keep the method of preparing theſe candles as ſecret as they can; but I ſhall communicate to the public what I have been able to learn reſpecting the proceſs.

"The only difference between theſe candles and the common tallow candles is, that the ground work of the wick conſiſts of a very thin ſlip of wood, bound round to a conſiderable thickneſs with very fine unſpun cotton; but in ſuch a manner that the ſize of the wick does not much exceed that of the wick of a common candle. The cotton is wound round the wick by the hand; but in general it is done by means of a reel, which I have not yet been able to ſee. The thin ſlips of wood are furniſhed to the candle-makers by the country people, and, if we may judge from

* There are no large manufactories of verdigriſe at Montpellier; but each family makes a certain quantity, and the operations are in general performed by women.

† From Riems *Neue Sammlung Oekonomiſcher Schriften*, part xii.

their

their appearance, are cut into the proper form by means of a knife, without the application of any machine. They are for the moſt part ſomewhat ſquare, and not completely rounded. The candle-makers often prepare theſe ſlips of wood alſo themſelves, when they have none ready by them, and for that purpoſe uſe pine, willow, and other kinds of wood, though they commonly employ fir. For making theſe candles it is neceſſary to have the pureſt tallow: a pound will be ſufficient to make ſix or ſeven, which coſt 25 kreutzers. The price of common moulded candles with cotton wicks is 22 kreutzers; but as the former burn much longer, they are on the whole cheaper."

Another method of making the wicks is as follows: Take ſhoots of the pine-tree a year old, ſcrape off the bark, and when they are become perfectly dry ſcrape them again all round till they are reduced to the ſize of a ſmall ſtraw. When the above wood cannot be procured, well dried common fir twigs of a year old, and of the ſame ſtrength, may be prepared in the like manner. Theſe rods are then to be rubbed over with wax or tallow, till they are covered with a thin coating of either of theſe ſubſtances; after which they muſt be rolled on a ſmooth table in very fine carded cotton, drawn out to about the length of the rod or candle-mould. Care however muſt be taken that by this rolling no inequalities may ariſe on the rod, and that the cotton may be every where of equal thickneſs, though at the upper part a little more of it may be applied. After this preparation the wick will have acquired the ſize of the barrel of a ſmall quill; and the more accurately the ſize of the wick is proportioned to that of the candle mould, the candles will burn ſo much the better, clearer and longer, as will ſoon be found by a little experience: theſe wicks are then to be placed very exactly in the middle of the mould, and retained in that poſition, and good tallow, freſh if poſſible, previouſly melted with a little water, muſt be poured round them; but even old and rancid tallow will not run, if the wicks be properly made.

Theſe candles, beſides burning longer than the common ones, have alſo this advantage, that they do not flare, and that they are leſs prejudicial to the eyes of thoſe who are accuſtomed to read or write at night. It is however to be obſerved, that a pair of ſharp ſciſſars muſt be employed for ſnuffing them, and that in performing that operation care muſt be taken not to break or derange the wick.

XIII. *Experiments on the Colouring Matter of Vegetable Juices with the Tungſtic Acid. By Cit.* GUYTON.

IN the ſecond volume of the Philoſophical Magazine, page 126, we laid before our readers a paper by the ſame author on the colouring matter of vegetables, and the action exerciſed on it by metallic ſubſtances and their oxyds; with a new proceſs for obtaining lakes of more intenſe and fixed colours. The preſent may be conſidered as connected with that paper, being, in fact, a detail of the experiments with tungſten, on which the concluſions there given were eſtabliſhed.

"Having ſubjected to experiment an oxyd hitherto little known, I mean the tungſtic oxyd, I ſoon diſcovered that it is one of the moſt valuable ſubſtances for receiving and fixing vegetable colours. I digeſted the juice of the red plum with the white oxyd of tungſten, procured from wolfram, that is to ſay, in the ſtate in which it is conſidered as an acid. The liquor loſt a great deal of its colour, and the metallic oxyd became of a very dark red violet. I decanted the liquor, and boiled it on a new portion of the tungſten. It aſſumed the ſame colour, and the liquor ſtill retained a faint ſhade of red. The liquor being filtered and diluted with water, to defend it from the action of the fire, was treated a third time with freſh oxyd. It then remained colourleſs, and the oxyd of tungſten was found coloured as much as the firſt.

* From Annales de Chimie, No. LXXXIX.

" It was not now neceſſary to examine the liquor by reagents, for principles which no longer exiſted in it, but to try whether the colour adhering to the oxyd was fixed there in ſuch a manner as to promiſe any advantages to dyeing, or at leaſt to painting. Water boiled a long time, and in ſucceſſion, on this oxyd rather darkened than weakened its colour. This water made no impreſſion upon turnſol paper. Though limpid, it aſſumed, by the addition of the muriatic acid, a ſhade of a pale roſe red colour; and by the addition of pot-aſh, a greeniſh ſhade; but theſe colours totally diſappeared in a few minutes, and could not be made to reappear, by pouring over them freſh acid and freſh alkali. What is more remarkable, the hydro-ſulphure brought back a ſlight tint of violet, which did not diſappear.

" A portion of the coloured oxyd of tungſten was mixed up with gum water, and with a bruſh daubed over a piece of paper. The ſtratum being dry, a thin ſcale of it was detached, in order to be expoſed to the rays of the ſun, and at the end of nine days the colour was neither changed nor weakened. Another ſcale was immerſed in the acetous acid; and being immediately drawn out and dried, it was found to have experienced no change. As little effect was produced upon it by the acetic acid. Lime water applied to it left no ſenſible traces of its effect. The caſe was the ſame with ammonia. A ſolution of ſoap only weakened the tint without changing it. A ſolution of potaſh made a red ſpot, in which the violet ſhade was deſtroyed. A ſolution of the carbonat of potaſh produced an alteration ſtill more ſenſible, the part which had been touched inclining rather to yellow than to red. A ſolution of alum, even concentrated, effected no change. A ſheet of paper, tinged with the colour of this oxyd, being kept for twenty-four hours in a cloſe jar, at the bottom of which was ſome hydro-ſulphure, no change whatever was obſerved. In the laſt place, a ſheet of this paper expoſed to the vapour of the oxygenated muriatic acid, at the ſame time as a like ſheet of paper coloured by turnſol,

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the latter loſt all its colour, while that of the former was not ſenſibly weakened.

"The kind of lake formed by the union of vegetable colouring matter with the oxyd of tungſten may be conſidered, therefore, as having been ſubjected to the ſtrongeſt teſt by the principles moſt deſtructive to colours, and which Berthollet conſiders as the neareſt, in point of ſtrength, to the continued action of the air and light.

"I ſhall paſs over a great number of other experiments leſs direct, or at leaſt leſs concluſive, reſpecting other vegetable colouring matters, and obſerve only that the oxyd of lead, which ſeems to have ſo little action on the red juice of ſtoned fruits, attacks turnſol very ſtrongly; that an infuſion of turnſol, rendered red by the acetous acid, paſſes to a wine colour when treated with iron, and is then in the ſtate of violet juices which become green by alkalies; that the acid juice of yellow fruits, melons for example, gives to the oxyd of tungſten only a faint ſhade of blue, which turns grey by repeated waſhing; and that, on the other hand, this oxyd, digeſted in infuſions of curcuma (turmeric) and turnſol, becomes charged with their colours, and gives them a fixity of which one would not have ſuppoſed them ſuſceptible."

XIV. *Deſcription of an Apparatus in the Teylerian Muſeum for the Combuſtion of Phoſphorus in Oxygen Gas; with Obſervations on the Shining of Phoſphorus in Azot.* By D. van Marum *of Haarlem* *.

HAVING made ſeveral fruitleſs attempts to render a balloon for the combuſtion of phoſphorus perfectly air-tight, according to the method deſcribed by Lavoiſier in his Elements of Chemiſtry, I conſtructed another like that which I employ-

* From *Deſcription de quelques appareils Chimiques*, &c. by Dr. van Marum.

ed for the compoſition of water, and ſecured againſt the entrance of air in the like manner. This balloon, repreſented by A (Plate II.), has two cocks B C with conical ſtoppers, and united to the tubes by the ſame means as thoſe in the gazometer above mentioned*. Within the balloon is a ſmall crucible of platina, *d*, ſuſpended by two wires of the ſame metal from the plate of copper by which the balloon is ſhut. The cock B ſerves to connect the tube with an air pump, and by theſe means to empty the balloon of atmoſpheric air. By the cock C, the oxygen gas, contained in the gazometer G, is introduced; but as this gas ought to be as dry as poſſible before it is admitted into the balloon, I have applied between it and the gazometer a glaſs cylinder, H, filled with a ſalt which ſtrongly attracts the moiſture of the gas. The ſalt which I found moſt effectual in this experiment was that uſed and recommended by Sauſſure for drying atmoſpheric air†. It is the alkali which remains after the decrepitation of a mixture of equal parts of nitre and crude tartar, and which has been kept at a red heat for an hour.

The ſalt in the tube H muſt not be pulveriſed, but divided into ſmall fragments, in order that the gas may penetrate through it, and come in contact with a greater portion of its ſurface. The tubes *i*, *u*, *k*, by which the cylinder H is connected with the gazometer and the balloon, muſt be pliable, becauſe it would be too difficult to place the cylinder H in ſuch a poſition as to be united with the balloon and gazometer by means of tubes not capable of being bent. I employ pliable tubes of gum elaſtic, the ends of which are faſtened to the copper pipes ſcrewed into the cocks.

Lavoiſier kindled the phoſphorus in the balloon by a burn-

* For a deſcription of the gazometer, or apparatus for producing water by combining hydrogen with oxygen, here referred to, ſee the *Philoſophical Magazine*, vol. ii. p. 85.

† See De Sauſſure's *Eſſais ſur l' Hygrometrie*, p. 25.

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ing glaſs. I have obſerved that phoſphorus wrapt up in a particular manner inflames ſpontaneouſly when the air is rarefied to a certain degree; and I employ the reſult of this obſervation to inflame the phoſphorus in the balloon.

By means of this apparatus I have ſeveral times, both in the courſe of my lectures and on other occaſions, ſhewn the production of the phoſphoric acid by the combuſtion of phoſphorus in oxygen gas, as deſcribed by Lavoiſier in the Memoirs of the Academy of Sciences for the year 1777, (page 65.) In my experiments I have generally burnt ſixty grains of phoſphorus. They have ſhewn that the weight of the phoſphoric acid produced is always nearly equal to that of the phoſphorus burnt, and of the oxygen gas employed. I calculated the reſults by the method deſcribed by Lavoiſier in his Treatiſe of Chemiſtry (vol. ii.); but it is not neceſſary they ſhould be inſerted here, as the compoſition of the phoſphoric acid has been ſufficiently eſtabliſhed by the accurate experiments of Lavoiſier. My object, in deſcribing the apparatus I employed, was merely to enable thoſe who wiſh to repeat the experiments to do ſo by an eaſier method, and with more certainty than according to that propoſed by him. It muſt here be obſerved, that as the phoſphorus, by my proceſs, inflames in rarefied air, there is no danger that the ſudden expanſion of the air, produced by the intenſe heat of the inflamed phoſphorus, will burſt the glaſs; to prevent which, in Lavoiſier's method, requires great caution, as he himſelf has remarked. That the balloon during the combuſtion may be as little heated as poſſible, I ſuffer the air, after the inflammation, to paſs gradually, and in ſmall quantity, into the glaſs globe, and for that reaſon do not open the cock until the flame begins to be extinguiſhed. In this manner the experiment may be performed without any danger.

In the year 1794 I made known, in the thirteenth number of the *Chemiſchen Oeffeningen* of the celebrated Kaſtel-

lyn, my experiments on the combuſtion of phoſphorus in the ſo called vacuum of an air pump. Had profeſſor Göttling, and other German chemiſts who have obſerved phoſphorus to ſhine in azotic gas, paid more attention to what theſe experiments clearly eſtabliſh, they would not have made ſo much noiſe reſpecting a phenomenon which is ſo like the ſhining of phoſphorus before it inflames in air highly rarefied. This ſhining of phoſphorus in an imperfect vacuum, ſhews that the ſmall quantity of oxygen gas contained in atmoſpheric air ſo highly rarefied, is ſtill ſufficient to occaſion that luminous appearance; and as it is well known that it is abſolutely impoſſible to produce azotic gas which does not contain ſome oxygen gas, they might have ſeen by my experiments, that the ſmall quantity of oxygen which muſt have been contained in their azotic gas was ſufficient to produce that light which they obſerved.

I ſhall here only add, that phoſphorus will not ſhine at all in azotic gas which contains no oxygen gas. This I ſhewed, on the 18th of January 1794, in my lectures at the Teylerian Inſtitute. I introduced azotic gas over mercury, and freed it totally from oxygen gas by introducing phoſphorus into it on the point of a bent iron wire, which I paſſed up through the mercury, ſo as to bring the phoſphorus in contact with a piece of ignited iron previouſly introduced into the receiver. All the oxygen gas united itſelf in a moment with the volatilized phoſphorus; and another bit of phoſphorus, which after the cooling of the apparatus I made to riſe through the quickſilver into the azotic gas, which in that manner was freed from all oxygen, did not ſhine. A ſmall bubble of atmoſpheric air was ſufficient to reproduce the ſhining. It was then ſeen diffuſed throughout the whole gas, in the ſame manner as when atmoſpheric air is admitted into an exhauſted receiver in which phoſphorus has ceaſed to be luminous. I ſhewed, in the courſe of the ſame lecture, that phoſphorus does not ſhine in a perfect vacuum.

vacuum. For this purpose I caused the phosphorus to ascend through the quicksilver of a barometer, and it exhibited no light*. In order that this experiment may completely succeed, you must employ a barometer, the tube of which has been well freed from atmospheric air, by boiling the quicksilver in the tube. If you use a barometer the quicksilver of which has not been boiled, the small quantity of air contained in it will be sufficient to make the phosphorus luminous; but this appearance will be of short duration, because the exhausted space of such a barometer can contain only a very small quantity of oxygen gas.

XV. *A simple Method of determining the magnifying Power of Telescopes. By Mr.* S. Varley. *Communicated by the Author* †.

THOUGH the subject on which I wish to trouble you with a few observations must be well understood by many of

* It has been already incontestably proved by experiments, that phosphorus is not luminous in a vacuum. Besides those mentioned in the treatise entitled *Ueber das Leuchten des Phosphors im atmosphärischen Stickgas*, Weimar 1795, p. 58, may be mentioned the following: Hawksbee approached very near to this discovery, and to that also, made by the author, of phosphorus inflaming in vacuo. He drew some lines with phosphorus on a piece of paper, and suspended it within the receiver of an air pump. "After long pumping," says he, "the luminous appearance was apparently brighter." See the *Philosophical Transactions*, vol. xxiv. p. 1865. Lemery mentions experiments of the like kind made by Homberg, in conjunction with M. D'Alence, at Paris, and which correspond exactly with those of Hawksbee. See his *Cours de Chymie*, Paris 1687, p. 577. Lavoisier found that phosphorus did not inflame, *Memoires de l' Academie*, an. 1777, p. 65; and Professors Lempe and Lampadius, that phosphorus was not luminous in the Torricellian vacuum. See Scherer's *Nachträge*, p. 200.

† A "Constant Reader," in a letter of 23d May, but which did not reach us in time for our last Number, proposed the following question:

your readers, I have had many opportunities of being convinced that it is not ſo generally known as it ought. Since I firſt ventured to give public lectures on optics, and to explain the various conſtructions of teleſcopes and microſcopes, I have frequently been applied to, to procure thoſe inſtruments for people reſiding at a diſtance from the metropolis, and to prove them before ſending them off. I have alſo been frequently requeſted by thoſe who had purchaſed ſuch inſtruments to give an opinion of their goodneſs, and to determine their magnifying powers; from which I have found that the manufacturers of thoſe inſtruments too generally are in the habit of over-rating their powers *, to the great diſappointment of the buyer, who finds, when too late, that they will not perform what he had been taught to expect from them.

From what I have ſtated, it appeared to me, that a method to determine the magnifying power of teleſcopes, without much trouble or expenſe, and yet ſufficiently exact for moſt purpoſes, might be thought worth a place in your uſeful publication. There are various methods of doing the ſame thing, and each have their particular advantages and diſadvantages: ſome are expenſive; others require long calculations: ſome are attended with much trouble; and others require particular ſituations, which cannot always be commanded. The method I moſtly uſe can be univerſally ap-

" What is the method uſed by opticians to aſcertain the magnifying power of teleſcopes? and how do they *prove* how many times the object is magnified, when ſeen through the ſame?"

The preſent paper, he will ſee, furniſhes a ſatisfactory anſwer. EDIT.

* Even that eminent artiſt Mr. James Short, who rendered himſelf ſo juſtly famous by bringing the reflecting teleſcope to a degree of perfection unknown before his time, too often over-rated the power of his teleſcopes, though not in the ſame ſhameful degree that ſome makers now do. I would not however be underſtood as making this cenſure general: I know one artiſt whoſe reflecting teleſcopes exceed even thoſe of Short, and whoſe teleſcopes I have never once found of leſs magnifying power than they were ſold for; and I hope there are others who are above being guilty of ſo mean an artifice.

plied,

plied, and at almoſt no expenſe; a ſmall ſcale, a pair of compaſſes, and a piece of paper, being all that is neceſſary.—It may be proper, in the firſt place, to ſtate the ſenſe in which I uſe the term *magnifying power of a teleſcope*; for it is differently underſtood by different perſons: alſo to diſtinguiſh between the object itſelf, and the magnified image of the object looked at, as ſeen in the field of the teleſcope. The difference in ſize, between the object viewed with the naked eye and its image as ſeen in the field of the teleſcope, conſtituting the magnifying power of the teleſcope, the queſtion is, How ought this difference to be expreſſed? Should it be expreſſed in a compariſon of their reſpective diameters, areas, or ſolidity? For inſtance, if a piece of paper of three inches ſquare, croſſed each way by three lines, and thus divided into nine ſquares, be placed at a diſtance, and viewed by a teleſcope that cauſes one of thoſe ſquares to appear as large as the whole paper, at the ſame diſtance, appears to the naked eye; if we compare this effect by the difference in diameter, we ſhould ſay, *the inſtrument magnifies three times:* but as one ſquare appears as large, when ſeen through the teleſcope, as the whole nine do to the eye unaſſiſted by that inſtrument, might it not be aſſerted, with equal truth, that it is magnified nine times? The latter appears as reaſonable as the former; but, as in this caſe the paper appears, when viewed by the teleſcope, of the ſame dimenſions as it would do to the naked eye when placed *at one third the diſtance from the obſerver*, it is moſt uſual to ſay, it is magnified three times. Some people, who yet mean the ſame thing, ſay, but improperly, that it appears three times nearer than it really is. Again, if an object at the diſtance of 100 yards appears by the teleſcope as large and diſtinct as it would do to the naked eye at the diſtance of one yard, it is ſaid to be magnified one hundred times; and it is to be underſtood in this ſenſe in the following experiments:—By a teleſcope of the laſt mentioned power, a printed paper, at the

diſtance of 100 yards, can be as diſtinctly read as it could by the eye at the diſtance of one yard; and it is owing to this aſtoniſhing property that the heavenly bodies can be contemplated as though they were only the one, two, three, four, or five hundredth part the diſtance that they are in reality.

The planets, for inſtance, have nothing in their appearance to the naked eye, that would engage our particular attention, or enable us to diſtinguiſh them from the fixed ſtars, except their being obſerved to change their places amongſt the fixed ſtars, ſometimes moving from weſt to eaſt, then for a ſeaſon remaining ſtationary, having no *apparent* motion at all; then again, to have a little motion from eaſt to weſt, which keeps increaſing a certain time, when it again decreaſes, until they once more become ſtationary. They were thus diſtinguiſhed from the fixed ſtars long before teleſcopes were invented, and on this account were called erraties, or wandering ſtars, their real and regular motions and periods being at that time unknown. But, by the aſſiſtance of the teleſcope, in each of them may be obſerved what excites aſtoniſhment and claims our particular attention, eſpecially if the inſtruments are good of their kind, and magnify from two to four hundred times. In viewing Saturn, the floweſt, and now known to be the moſt diſtant planet of all, except the Georgium Sidus, inſtead of a pale ſolitary wanderer, he is found to be accompanied with ſix or ſeven moons, revolving round him at ſtated, fixed, and regular periods, and to be encompaſſed with (a greater wonder ſtill) a double ring, no where touching him, but ſuſpended ſo as to have its inſide edge every where twenty-one thouſand miles from his body. The planet Jupiter is obſerved to have ſeveral belts that appear, though upon his body, as having ſeveral ſpots, by which his diurnal motion on his axis is determined to be much quicker than that of our earth, being performed in about eight hours, notwithſtanding he is ſo much larger.

He is also seen to be accompanied with four moons, or satellites, revolving in certain periods: even their eclipses, which afford an excellent method for determining the longitude of places on our earth, can be distinctly seen. Mars is observed to have some spots near one of his poles, by which he is known to have a diurnal rotation round his axis. The beautiful planet Venus, that now adorns our evening sky, is observed to wax and wane like our moon; sometimes being merely a crescent, then horned like the moon only a few days old, then gibbous, afterwards full; exhibiting different phases like our moon, and thus affording an incontestible proof of the Newtonian system of astronomy, now universally adopted by men of science in every part of the world *.

The planet Mercury, though but seldom seen, yet deserves our attention, as he more frequently than Venus passes betwixt the sun and us, appearing like a patch upon the disc of the sun, and thus, to those that know how to avail themselves of these phenomena, gives additional proof of the truth of the present system. The splendid face of our moon, in her various phases, offers so many similarities to the earth which we inhabit, as leave but little room to doubt she is destined for the same grand end, an habitation for in-

* The truth of this system has been proved by innumerable observations made with this excellent instrument, by men every way qualified to judge, who with unwearied diligence, and without any bias or motive whatever but a strong desire to search out the truth, have examined and proved every part of it, and fixed it upon too strong a basis to be overturned or refuted by the ignorant or interested, who pretend to do so without possessing one single qualification to enable them to form a proper judgment in this matter, or a single pretension but what is founded in the grossest ignorance, accompanied with the most consummate assurance. But enough of this at present. Perhaps at a future opportunity I may offer some remarks upon, and throw together some of the leading features of the Newtonian system, for the sake of those who, for want of better information, are daily duped out of their money by the contemptible jargon of even the most ignorant and stupid of mankind.

telligent

telligent beings; thus anſwering the double purpoſe of an additional light to us, and a convenient habitation for others; while ſhe, in return, receives a like benefit from the earth, which anſwers the purpoſe of a luminary to her. She is ſeen to have broad ſeas, bounded with rocky ſhores; extended continents, diverſified with hill and dale; deep valleys and towering mountains; mountains, whoſe extended ſhadows can be traced, and as diſtinctly ſeen, as the ſhadow of a ſun-dial; and, lately diſcovered (owing to the great improvements made in teleſcopes), volcanic or burning mountains.

An eaſy method to determine the magnifying power of thoſe inſtruments, whoſe excellence it is to have made us intimately acquainted with the various phenomena above mentioned, and which give us ſources of enjoyment from the contemplation of diſtant terreſtrial objects, of which our forefathers had no conception, cannot but be acceptable to many, eſpecially to thoſe who have not the opportunity of employing the more expenſive proceſſes that are reſorted to for the ſame end.

The ſimpleſt method is, to meaſure the emergent pencil or cone of light, as it appears in the eye-hole of the teleſcope, and to divide the diameter of the aperture of the object-glaſs, if it is an achromatic, or of the great milla, if a reflector, by the diameter of this emergent pencil, and it will give the magnifying power. For this purpoſe, I take a piece of thin writing paper, a little more than two inches in length, and about half an inch in breadth; I draw with a good pen, or other proper inſtrument, the line *a*, *b*, fig. 28, (Plate I.) and then, with a pair of good dividers, I take from a ſcale one tenth of an inch, which I ſet off from *b* to *c*, and then, with the ſame extent, divide the line *a*, *b*, into 20 equal parts, making viſible marks or punctures at each diviſion. I then draw the line *a*, *c*, and make the diviſions 1, 2, 3, 4, &c. to 10, at every other diviſion or point made with the dividers, and put a little ſweet oil upon the paper

to

to make it more transparent. I sometimes omit making the lines 1, 2, 3, &c. and content myself with numbering every second hole made by the dividers; the numbers are to express, in hundredths of an inch, the distance of the lines *a*, *b*, and *a*, *c*, at those points where they are placed. Being thus provided, I adjust the telescope to distinct vision, by looking at some distant object, and then take off the eye-hole, if the telescope will admit it to come off, which reflectors always do, but the night eye-pieces of achromatics do not without taking away the first glass also. Having now directed the telescope to the open day-light, I take the divided paper in one hand, and a hand magnifier to view it with in the other, and apply the paper to measure the diameter of the bright pencil of light as it emerges from the eye-glass, and at that distance where it appears least in diameter, as at *c*, fig. 29, where the rays of light, having passed the lens *a*, converging to *c*, there cross each other, and proceed diverging to *d* and *e*: this place, where the paper is to be applied, will be easily known by observing, with your hand magnifier, (which should be of an inch, or at most an inch and half focus,) where the bright spot, as at *d*, fig. 28, appears distinct and well defined at the edges, and the filaments of the paper distinctly seen at the same time. A place on the paper may be found, where the bright spot will just fill up the space between the lines *a*, *b*, and *a*, *c*. Suppose this takes place at *d*, where it will be extremely near the third division, and of course three hundredths of an inch in diameter; and suppose your telescope to be a 30-inch achromatic, and the diameter of the object glass two inches and one tenth, or 210 such divisions; these, divided by three, will give 70 for the magnifying power of your instrument. Suppose, with a different eye-piece, the pencil of light only occupied the space between the lines at *i*, it would be one and one half of those divisions: in this case divide 210, the hundredths of an inch contained in the diameter of your object glass, by 1·5, and

it

it will give 140 for the magnifying power. Again, ſuppoſe with ſome other eye-piece the beam of light fills the lines at the fourth diviſion: divide your 210 by 4, and it will give 52·5 or 52, for the power. If your paper be oiled with good linſeed oil that has been boiled, ſuch as the painters call drying oil, it will laſt for many years, and have this advantage over the inſtruments made for this purpoſe which are ſold for 3l. 3s. that, as the ſcrew for receiving the dark glaſs projects beyond the place where the paper ſhould be held, the paper will bend, and thus can be introduced into its proper ſituation without producing any ſenſible error. Another method, which I ſometimes uſe in confirmation of the former, and which cannot fail to produce full conviction on the mind, is as follows: I meaſure the ſpace occupied by a number of the courſes of brick in ſome modern brick building, which, upon an average, will be found to have eight courſes in two feet: hence each courſe is three inches. I then cut a piece of paper three inches in height, and nearly of the length of a brick, which is about nine inches, ſo that it may repreſent a brick, but with this advantage, that its edges will be much better defined; and fixing the paper againſt the wall (ſee fig. 27), place the teleſcope to be examined at the diſtance of 50 or 100 yards from the wall; and looking through the teleſcope at the paper with one eye, and at the ſame time with the other eye looking paſt the teleſcope, I obſerve what extent of wall the magnified image of the paper appears to cover. I then count the courſes of bricks in that extent, which gives the magnifying power of the teleſcope. This method will appear a little difficult at firſt, but, by a few trials, will become ſo familiar, that the paper, as ſeen by the teleſcope, may be eaſily compared with the bricks ſeen by the other eye.

I intended to have added ſeveral other obſervations on ſubjects nearly related to the above; but having exceeded the

the bounds I propoſed to myſelf, muſt reſerve them for a future number, if you ſhould think ſubjects of this nature worth inſertion*.

XVI. *Sixth Communication from Dr.* THORNTON, *Phyſician to the General Diſpenſary, &c. &c. relative to Pneumatic Medicine.*

A REMARKABLE CASE OF PULMONARY DISEASE CURED BY THE INHALATION OF HYDRO-AZOTE.

MR. GREGORY, M. P. of Berner's-ſtreet, who had been long reſident in India, laboured for ſeveral months under all the ſymptoms of phthiſis pulmonalis. He expectorated a quantity of thick, opaque, and yellowiſh matter which ſunk in water, had diſturbed nights, was greatly waſted, and his breathing was ſhort and interrupted. He took by my order (which was executed by Mr. Leaton, a very ingenious apothecary and able chemiſt, who lives in Bridge-ſtreet, Weſtminſter) from four to ſix quarts hydro-azote daily, mixed with twelve of atmoſpheric air, and at the ſame time had a mixture of myrrh and bark, with opiates occaſionally; and under this treatment the cough was ſoon diminiſhed, and in ſix weeks the patient was reſtored to health, and has continued free from every complaint theſe eight months; even a cold now paſſes off without exciting any ſymptoms of alarm. Dr. Hooper, of the Mary-le-bone Infirmary, and ſeveral others of the Faculty, who have ſeen this caſe, think that it may be produced as a very ſtrong argument in favour of the pneumatic practice.

* Subjects handled in the familiar and popular manner which Mr. Varley ſo ſucceſsfully follows, cannot fail to be uſeful, not only to the caſual examiner, but to men of ſcience; and we ſhall be happy to receive his communications as often as his other avocations will allow. EDIT.

Obſervation.

Obſervation.

The hydro-azote is made by burning æther under a bell-glaſs, when the oxygen unites with the hydrogen and forms water, and the reſidue is azotic air; a ſpecies of heavy, inflammable, or hydrogen air, and ſome æther in the ſtate of vapour, and a ſmall proportion of fixed air. I have myſelf inhaled ten quarts of this pure, and the pulſe has ſunk from eighty to ſeventy beats in a minute, and continued ſo for a quarter of an hour or more. It is very grateful to the lungs; and I flatter myſelf, that this new ſpecies of air, firſt employed by me, may prove hereafter a valuable acquiſition to the *ars medendi*. As we brace the conſtitution with tonic medicines, thereis danger of local inflammation, which this appears to obviate; or, has the hydro-azote any peculiar healing quality?

XVII. *Biographical Memoirs of M. de* Sauſſure. *By A. P.* Decandolle †.

Horace Benedict de Sauſſure was born at Geneva in 1740. His father, an intelligent farmer, to whom we are indebted for ſome memoirs relating to rural economy, reſided at Conches, a place ſituated on the banks of the Arve, at the diſtance of half a league from Geneva; and this country life, added to an active education, expanded no doubt in young De Sauſſure that phyſical ſtrength ſo neceſſary to the naturaliſt who devotes himſelf to travel. He repaired daily to town to enjoy the advantage of public inſtruction; and as he lived at the bottom of Saleve, a mountain which he has ſince rendered celebrated, he amuſed himſelf frequently with aſcending its ſteep and rugged ſides. Being thus ſurrounded by the phenomena of nature, and at the ſame time aided by ſtudy, he conceived a taſte for natural hiſtory, and avoided the error both of the learned, who form theories without

† From *Decade Philoſophique*, No. XV.

having

having been out of their cloſets, and of thoſe farmers who, living too near to nature, are incapable of admiring her beauties.

His earlieſt paſſion was botany: a variegated ſoil, abundant in plants of different kinds, invites the inhabitant of the banks of the Leman to cultivate that agreeable ſcience. This taſte produced an intimacy between De Sauſſure and the great Haller. He paid him a viſit in the year 1764, during his retreat to Bex; and he relates in his travels how much he admired that aſtoniſhing man, who excelled in every part of the natural ſciences. De Sauſſure was induced alſo to ſtudy the vegetable kingdom, by his connexion with Ch. Bonnet, who had married his aunt, and who ſoon ſet a juſt value on the riſing talents of his nephew. Bonnet was then employed on the leaves of plants. De Sauſſure ſtudied theſe organs of vegetables alſo, and he publiſhed the reſult of his reſearches, under the title of *Obſervations on the bark of leaves.* This ſmall work, which appeared ſoon after the year 1760, contains new obſervations on the epidermis of leaves, and in particular on the miliary glands by which they are covered *.

About that period the place of profeſſor of philoſophy falling vacant, it was conferred upon De Sauſſure, who was then only twenty-one years of age. Experience proves, that if premature rewards extinguiſh the zeal of thoſe who labour merely for themſelves, they, on the contrary, ſtrengthen it in thoſe who labour only for truth. At that time the two profeſſors of philoſophy at Geneva taught phyſics and logic alternately. De Sauſſure diſcharged this double taſk with equal ſucceſs. He gave to his courſe of logic a practical, and, as one may ſay, experimental turn; and his method of teaching, which began by ſtudying the ſenſes to arrive at the general laws of the underſtanding, announced already an able obſerver of nature.

Phyſics however were the part for which he had the greateſt taſte, and which conducted him to the ſtudy of chemiſtry

* He had reſumed this ſubject eighteen months before his death.

and mineralogy. He then began his travels through the mountains; not now to examine their vegetable productions, but to ſtudy the mountains themſelves, either in the ſtones of which they are compoſed, or the diſpoſition of their maſſes. Geology, a ſcience which was then ſcarcely in exiſtence, added charms to his numerous excurſions through the Alps; and it was then that the talents of the great philoſopher were really diſplayed. During the firſt fifteen or twenty years of his profeſſorſhip, he employed himſelf by turns in diſcharging the duties of his office, and in traverſing the different mountains in the neighbourhood of Geneva. He even extended his excurſions on one ſide as far as the banks of the Rhine, and on the other to Piedmont. At the ſame time he undertook a journey to Auvergne to examine there the extinguiſhed volcanoes, and another to Paris, England, and Holland. After that he viſited Italy, and even Sicily. Theſe were not mere journeys for the purpoſe of reaching any particular place. He undertook them only with a view of ſtudying nature; never travelled but ſurrounded by every inſtrument that could be of uſe to him, and never ſet out until he had drawn up a plan of the experiments and obſervations he intended to make. He often ſays in his works, that he had found this method exceedingly uſeful.

In the year 1779 he publiſhed the firſt volume of his *Travels through the Alps*, which contains a minute deſcription of the environs of Geneva, and an excurſion as far as Chamouni, a village at the bottom of Mont-Blanc. Philoſophers will read there with pleaſure the deſcription of his *magnetometer*. The more he examined mountains, the more was he ſenſible of the importance of mineralogy. To ſtudy it with advantage, he learned the German language; and it may be ſeen, in the laſt volumes of his Travels, how much new mineralogical knowledge he had acquired.

Amidſt his numerous excurſions through the Alps, and at the time of the political troubles of Geneva in 1782, he found means to make his beautiful experiments on hygrometry, which

which he publiſhed in 1783 under the title of *Eſſays on Hygrometry*. This work, the beſt that ever came from his pen, eſtabliſhed fully his reputation as a philoſopher. We are indebted to him alſo for the invention of a new hygrometer. Deluc had already invented his whalebone hygrometer; and on that account there aroſe between him and De Sauſſure a ſort of conteſt, which degenerated into a pretty violent diſpute.

In the year 1786 De Sauſſure reſigned the profeſſor's chair, which he had filled for about twenty-five years, to his pupil and fellow-labourer Pictet, who diſcharged with reputation the duties of an office rendered more difficult by ſucceeding ſo eminent a philoſopher.

When De Sauſſure was invited by the ſtate to take a ſhare in the public education, he made it one of the ſubjects of his meditations, and preſented the plan of a reform in the education of Geneva, the tendency of which was, to make young people early acquainted with the natural ſciences and mathematics. He even wiſhed that their phyſical education ſhould not be neglected, and with that view propoſed gymnaſtic exerciſes. This plan, which excited much attention in a city where every one is convinced of the importance of education, found admirers and partiſans; but the poverty of its pecuniary reſources was an obſtacle to every important innovation. It was beſides feared that, by altering eſtabliſhed forms, they might loſe the ſubſtance, and that things might be changed for the worſe. The Geneveſe were attached to their old ſyſtem of education; and they had reaſon to be ſo, becauſe it had not only proved the means of diffuſing knowledge generally amongſt them, but had called forth the talents of ſeveral eminent mathematicians* and philoſophers†.

But De Sauſſure's attention was not confined to public edu-

* Abauzit, Cramer, Lhuilier, J. Trembley, &c.

† Jalabert, A. Trembley, Bonnet, Leſage, Deluc, Senebier, Prévoſt, Pictet, and De Sauſſure himſelf.

cation alone. He ſuperintended himſelf the education of his two ſons and a daughter, who have ſhewn themſelves worthy of ſuch an inſtructor. His daughter to the charms of her ſex unites an extenſive knowledge of the natural ſciences; and his eldeſt ſon has already made himſelf known by his phyſical and chemical labours.

The ſecond volume of his Travels was publiſhed in 1786. It contains a deſcription of the Alps around Mont-Blanc, which the author conſiders as a mineralogiſt, a geologiſt, and a philoſopher. He gives alſo ſome intereſting experiments on electricity, and a deſcription of his electrometer, the moſt perfect we have. We are indebted to him alſo for ſeveral inſtruments of meaſurement, ſuch as his *cyanometer*, deſtined to meaſure the degree of the blueneſs of the heavens, which varies according to the elevation of the obſerver: his *diaphanometer*, or inſtrument for meaſuring the tranſparency of the atmoſphere; and his *anemometer*, which, by means of a kind of balance, weighs the force of the wind.

Some years after the publication of the ſecond volume of his Travels, De Sauſſure was admitted as a foreign aſſociate of the Academy of Sciences of Paris; and Geneva could then boaſt of having two of its citizens in that claſs, which conſiſted only of ſeven members. De Sauſſure not only did honour to his country: he loved and ſerved it. He was the founder of the Society of Arts, to which Geneva is indebted for the high ſtate of proſperity it has attained within the laſt thirty years. He preſided over that ſociety till the laſt moment of his life, and one of his fondeſt wiſhes was the preſervation of this uſeful eſtabliſhment.

In conſequence of M. de Sauſſure's fatiguing labours in the Council of Two Hundred, of which he was a member, and afterwards in the National Aſſembly, his health began to be deranged, and in 1794 he was almoſt deprived of the total uſe of his limbs by a ſtroke of the palſy. However painful his condition then might be, his mind ſtill preſerved its activity;

activity; and after that accident he reviſed the two laſt volumes of his Travels, which appeared in 1796. They contain an account of his excurſions to the mountains of Piedmont and Swiſſerland, and in particular of his journey to the ſummit of Mont-Blanc. Theſe volumes, inſtead of exhibiting any marks of his malady, preſent an enormous maſs of new facts and obſervations of the utmoſt importance to phyſics.

He rendered alſo an important ſervice to that ſcience by publiſhing the *Agenda**, which terminate his fourth volume, and in which that great man, ſurviving himſelf, conducts the young naturaliſt through the middle of mountains, and teaches him the method of obſerving them with advantage. Theſe *Agenda* are a proof of his genius, and of the ſtrength of mind which he retained amidſt his ſufferings. It was alſo during his illneſs that he publiſhed *Obſervations on the fuſibility of ſtones by the blow-pipe*, and that he directed the experiments made on the height of the bed of the Arve *. Having gone for the ſake of his health to the baths of Plombiers, he ſtill obſerved the mountains at a diſtance, and cauſed to be brought to him ſpecimens of the ſtrata which he perceived in the ſteepeſt rocks. He had announced that he would conclude his Travels with ſome ideas on the primitive ſtate of the earth; but the more he acquired new facts, and the more he meditated on the ſubject, the more uncertain did his opinions become in regard to thoſe grand revolutions which preceded the preſent epoch. In general he was a Neptunian; that is to ſay, aſcribed all the revolutions of our globe to water. He admitted the poſſibility of the mountains having been thrown up by elaſtic fluids diſengaged from the cavities of the earth.

Though the ſtate of his health began gradually to become

* Part of theſe *Agenda* have been already given in the *Philoſophical Magazine*: the reſt will be given in the ſubſequent numbers. EDIT.

* His memoirs on theſe ſubjects were inſerted in the *Journal de Phyſique*.

worſe, he ſtill entertained hopes of recovery; and the French government having appointed him profeſſor of philoſophy at the Special School of Paris, he did not deſpair of being one day able to fill that office: but his ſtrength was exhauſted, a general languor ſucceeded the vigour he had always enjoyed, his ſlow and embarraſſed pronunciation no longer correſponded with the vivacity of his mind, and formed a melancholy contraſt with the pleaſantneſs by which he had been formerly diſtinguiſhed. It was a painful ſpectacle to ſee this great man reduced thus to imbecility at an age when meditation is beneficial, and when he ought at leaſt to have enjoyed the fruits of his reputation and labours.

In vain did he try, for the re-eſtabliſhment of his health, all the remedies which medicine enlightened by the phyſical ſciences could afford—all aſſiſtance was uſeleſs. The vital power quitted him with ſlow and painful ſteps. Towards the beginning of autumn laſt year his decay became more viſible, his mind loſt all its activity, and on the 22d of March 1799 he terminated his brilliant career, at the age of 59, lamented by a family to whom he was dear—by a country to which he had done honour—and by Europe, the knowledge of which he had extended.

XVIII. *Letter from Dr.* CARMICHAEL SMYTH *to the Editor of the Philoſophical Magazine.*

SIR,

OBSERVING in your Magazine of laſt month an article in which Mr. Cruickſhank has corrected a miſtake I had fallen into in relating an experiment of his on variolous matter; I have only to ſay, that had this gentleman informed me of this circumſtance, I certainly would have ſaved him the trouble he has taken. As for the way in which the miſtake originated, although it could be eaſily explained; yet, as the recollection of this gentleman and of his friend

friend Dr. Rollo, in regard to the converſation that paſſed at the time, differ ſomewhat from mine, I chooſe to avoid the diſcuſſion of a queſtion that reſts on the memory of the parties.

Beſides, the miſtake once corrected, the public have no farther intereſt in it, and the perſon concerned almoſt as little. It did not in the leaſt affect the merit of the experiment, whether it was made in one way or the other; and it is equally evident that I could have no object in view, or purpoſe to ſerve, in miſrepreſenting it.

I have the honour to be, Sir, your obedient ſervant,

JAMES CARMICHAEL SMYTH.

Charlotte Street, Bloomſbury,
June 16, 1799.

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

DENMARK.

THE Society of Agriculture at Copenhagen has propoſed three prizes, to be paid by the admiralty, one of five hundred, one of a hundred, and one of fifty rix-dollars, for the beſt paper on the rearing of timber proper for ſhip-building. The points reſpecting which the ſociety wiſhes to be informed are: 1. What ſoil is beſt ſuited to the different kinds of wood, and what care is required in the cultivation of them? 2. Can the neceſſary form and degree of flexion be by any means given to the timber without injuring it? 3. What is the proper time for cutting the trees? 4. Is it

beneficial to bark the trees before they are cut, and in what manner is that operation to be performed? The anſwers to theſe queſtions muſt, as far as poſſible, be confirmed by experiments. If the author ſupports any of his obſervations on the authority of foreign publications, he muſt be careful to refer to them in a marginal note. The papers may be written in Daniſh, German, French or Engliſh, and muſt be tranſmitted to the Society before the month of October next.

GERMANY.

The following queſtion, in economics has been propoſed by the Royal Society of Gottingen: Has inoculation of the ſmall-pox in ſheep been attended with any real utility? does it ſecure them againſt infection? and what rules are to be obſerved reſpecting it? The Society wiſhes that the anſwers to this queſtion may be confirmed by undoubted experiments.

The prize is twelve ducats, and the papers muſt be tranſmitted to the Society before the month of September.

PROCEEDINGS OF THE INSTITUTE OF CAIRO.

Frimaire 1, *Seventh Year.* [*Nov.* 22, 1798.]

A memoir by C. Corancez was read, in which the author examined the means of remedying the alteration in the movement of watches, occaſioned by changes of temperature. He propoſed, for this purpoſe, that the balance ſhould be compoſed of different metals; and he examined by calculation what ought to be the form of the parts to render the *vis inertiæ* conſtant, while the oſcillating maſs dilates or contracts.

C. Savigny read a memoir on the natural hiſtory of Egypt, with an enumeration of the different ſpecies of animals hitherto obſerved in Lower Egypt, and particularly inſects. He pointed out alſo ſome of the cauſes which may have contributed to reduce the number of theſe ſpecies.

C. Sucy propoſed the appointment of a commiſſion for the purpoſe of collecting information from the inhabitants of countries adjacent to Egypt, which might then be at

Cairo,

Cairo, and in particular reſpecting the courſe of the upper part of the Nile, and the natural and civil hiſtory of Abyſſinia.

Frimaire 6. [*November* 27.]

C. Levaſſeur, director of the artillery and marine at Alexandria, tranſmitted to the Inſtitute a memoir on the different proceſſes proper to correct certain faults in various kinds of iron and ſteel.

C. Say propoſed that different pieces of coin, found in digging among the ruins of Bellecis, ſhould be depoſited in the library.

Frimaire 11. [*December* 2.]

C. Hybert, captain of the 85th demi-brigade, ſent to the Inſtitute an allegorical drawing made in honour of General Buonaparte.

C. Deſgenettes, in name of a commiſſion, gave in a report on the ophthalmy preſented by C. Larreſt, ſurgeon general to the army.

C. Monge read ſome obſervations he had made on the phenomena of capillary tubes.

Frimaire 16. [*December* 7.]

C. Balzac, architect, preſented a poetical piece on the relative ſituation of the French in Egypt.

C. Berthollet read a paper on dyeing cotton and linen with the carthamus. Egypt ſupplies Europe with the carthamus, and it is uſed there for dyeing ſilk. In Egypt it is employed in the dyeing of cotton, and the proceſs conſiſts, 1. In ſeparating, by means of a water a little alkaline, the yellow part from the red ſubſtance. 2. In incorporating the alkali under the grinding-ſtone with the carthamus. 3. In keeping the heat of the bath at the temperature of from 30 to 40 degrees [of Reaumur, we ſuppoſe].

C. Levaſſeur's memoir on correcting the faults in certain kinds of iron and ſteel having been referred to a commiſſion, a report on that ſubject was read by C. Deſcoſtils. Iron which breaks when forged cold is a mixture of two metals, one

one of which is more fuſible than the other; and it cannot be forged but when both metals are ſoftened by the action of heat, or when they are both cold. C. Levaſſeur pointed out therefore ſeveral methods of correcting cold ſhort iron, whether its defect ariſes from the ſteely quality it has retained, or from the preſence of phoſphorus. The means employed by the author to remedy the too great hardneſs of ſteel and ſteelified iron, were by ſubjecting them to cementation with oxygenated ſubſtances.

C. Buonaparte communicated to the Inſtitute an account of the number of perſons, inhabitants of Cairo, who had died in the courſe of a hundred days. The number was 1076, comprehending only Muſſulmans.

C. Monge announced, that it appeared from obſervations made lately at Cairo by C. Beauchamp, that the declination of the magnetic needle was $12\frac{1}{2}°$.

Frimaire 21. [*December* 12.]

C. Regnier preſented to the Inſtitute, from his brother General Regnier, ſpecimens of rock detached from a hill called Djebel Nabo. C. Berthollet and Deſcoſtils were charged to examine the nature of theſe ſpecimens.

C. Frank, phyſician, tranſmitted to the Inſtitute a paper reſpecting the art of the ophiogenes. The author had frequent opportunities of obſerving, in different parts of Egypt, the confidence and addreſs with which certain inhabitants of that country handled ſerpents; and his remarks on this ſubject will ſerve to illuſtrate the accounts given by travellers of the arts employed by theſe people.

Frimaire 26. [*December* 17.]

C. Fourier preſented to the Inſtitute a ſecond part of a treatiſe entitled *Reſearches in regard to Mechanics in general.*

The ſecretary read a poetical compoſition on the death of a young French ſoldier, who had been taken by the Arabs ſoon after the arrival of the army in Egypt.

C. Ripault,

C. Ripault, librarian, preſented a memoir, entitled *Reſearches reſpecting the Oaſis.*

ROYAL SOCIETY OF LONDON.

Since our laſt report papers on the following ſubjects have been read at the meetings of this learned body:—

On a new Principle in Tanning, by George Biggin, Eſq. From the experiments adduced in this paper it appears, that elm bark is the leaſt powerful of any, and that oak bark in winter is not ſo powerful as in ſpring in the proportion of 30 to 128.

On Lime employed for manure by Smythſon Tennant, Eſq. This paper contains much uſeful practical information reſpecting the effects produced by different kinds of lime-ſtones. One kind, found near Doncaſter, proves highly detrimental to the land on which it is laid, however ſparingly, ſo as to deſtroy almoſt entirely all vegetation: this miſchievous property is found to be owing to the preſence of a portion of magneſia. Near Ferry-bridge, on the other hand, a lime-ſtone is found which proves highly fertilizing applied in any quantity. This paper is accompanied with a table of different pernicious lime-ſtones found in various parts of the kingdom.

The reading of a paper on the Decompoſition of Borax by Profeſſor Crell, and an intereſting one on Shells and Bones, by Charles Hatchet, Eſq. terminated the ſeſſion, which was cloſed on the 13th inſtant.

AEROSTATION.

Several of the foreign journals have announced an invention of Profeſſor Danzel for directing an air balloon through the atmoſphere. The following is a ſhort account of the method. M. Danzel has conſtructed two cylinders or axles, to the ends of which are fixed, in the form of a croſs, four ſails or oars, moveable at the point of their inſertion into the cylinder, in ſuch a manner that, when made to move round by means of a handle, the eight oars, like the cogs of a water-

mill wheel, preſent in ſucceſſion to the air ſometimes their flat ſide and ſometimes their edge.

To cauſe each oar to turn back on itſelf about the fourth part of a circle, M. Danzel has not only left ſufficient play at the point where the ſtick of each oar is inſerted in the cylinder, but has placed the ſtick in ſuch a manner that the air itſelf makes the oar fall back, at each turn, with the neceſſary velocity and preciſion. It muſt here be underſtood that the two cylinders, armed with their four oars or ſails, are deſtined to occupy one each ſide of the balloon, four oars on each ſide.

It is well known that aëroſtation has a reſemblance to flying or ſwimming rather than to ſailing, ſince every aëroſtat is immerſed in the air as a bird, or as a fiſh is immerſed in water; whereas the effort of a veſſel is divided between two elements, one of which, the water, gives it a great point of ſupport, and the other, the air, is very eaſy to be divided. But the aëroſtat being totally immerſed in the air, it was neceſſary to find out a movement which, though circular, ſhould not deſtroy at each half turn the effect of the preceding one; for, the reſiſtance being equal in the whole circumference, it is evident that the ſupport muſt be diminiſhed or even annulled, if poſſible, in one half of the circle, and be retained full and perfect in the other. This M. Danzel has effected, by preſenting to the air ſometimes the edge and ſometimes the flat part of the ſails on each ſide, in turns and with great regularity. The reſult is, that during a continued rotation each cylinder produces a ſtrong current of air behind, and rarefaction before; and this current, which continues without intermiſſion, is very ſenſible. It is evident then that a body ſuſpended in air at reſt, if theſe two cylinders are attached to it, muſt advance towards the rarefied ſpace occaſioned by their rotation, and produce a continual current of air behind it.

The cogged wheels of water mills being half in the water and half in air, the cogs may be immoveable, becauſe at each

each half turn the force of the water overcomes the reſiſtance of the air, in the proportion of a thouſand to one; but if the wheel with its immoveable cogs were entirely immerſed in a current of water, it is evident that it would not turn at all, becauſe the water would make two efforts in oppoſite directions on the upper and lower cogs. If we now ſuppoſe ſuch a cogged wheel totally immerſed in ſtagnant water, and that by means of any power it is made to turn on itſelf, it will only agitate the water without producing a current; and if it be free to advance or recede, it will do neither. But if the cogs are rendered moveable by M. Danzel's method, in ſuch a manner that the wheel preſents alternately at each half turn the flat ſide and the edge, it will neceſſarily advance, and occaſion a current of water behind it.

NAVIGATION.

M. Danzel has invented alſo an hydraulic machine for making a ſhip or boat advance during a calm, and even againſt a current. The mechaniſm of this machine is extremely ſimple; and if we did not know that the ſimpleſt means are often diſcovered the lateſt, we might be ſurpriſed that it ſhould not have been found out before. It conſiſts of a long pole, to the anterior extremity of which an apparatus, ſhaped like a drawer without back or front, is attached in ſuch a manner that when puſhed forwards it folds itſelf back under the pole, to which it as it were adheres, and preſents to the water the thin cutting ſurface of its three edges, viz. of the bottom and two ſides, which can neither oppoſe to the water a reſiſtance capable of preventing the pole from penetrating farther, or of making the ſhip recede.

When the pole, which is puſhed forwards from the veſſel, has attained to its full reach, the drawer as ſoon as the pole is pulled back aſſumes a vertical poſition, and preſents to the water its whole cavity. By theſe means it embraces a column of water, which, without finding means to eſcape, preſſes on

a ſurface much larger than that of a common oar, and keeps the drawer immoveable; ſo that thoſe who draw the pole towards them, inſtead of making the veſſel to recede, cauſe it to advance. This machine, which may be multiplied more conveniently than oars, has this viſible advantage over the latter, that it oppoſes to the water a reſiſtance infinitely ſuperior, while the paſſive re-action of this reſiſtance renders the labour of the mariners leſs laborious and more effectual.

METEOROLOGY.

The following note has been lately publiſhed by Delalande in one of the French Journals:

"M. Von Zach, director of the obſervatory of Gotha, the moſt celebrated and moſt uſeful aſtronomer of Germany, and whom I viſited laſt ſummer, informs me, in one of his letters, that on the 25th of December he ſaw the thermometer at 21° Fahr. below 0°. In the duchy of Wirtemberg it was at 24°, at Augſbourg 25°, at Manheim 19°, at Vienna 18°, at Amſterdam 16°, at Dreſden 4° as at Paris; but at Copenhagen, which is much farther north, it was only at 10 degrees. Thus the cauſe of this great cold did not come from the north, but probably from Siberia and Tartary. I am accuſed of having predicted that the winter would be *moderate*. This is not correct. Some weak perſon had ſaid, in one of the Journals, that every 400 years the winter was ſevere, and that the laſt one correſponded with that period. I replied, that the period of 400 years had no foundation; and that, if there were any probable means of foretelling any thing, it would be by the period of 18 years: it has ſucceeded ſometimes. M. Toaldo aſſerts, that in Italy it ſucceeds always; and it was this which promiſed us a moderate winter. On this ſide the Alps, and the Pyrenees, local circumſtances, which cannot be explained, derange often our calculation and the period. I gave that conjecture therefore only as probability, but it has been improperly conſidered as a prediction." LALANDE.

INOCU-

INOCULATION OF SHEEP.

It appears that the practice of inoculating ſheep for the ſmall-pox is now common in Germany. We are informed that a M. von Hofman cauſed this operation to be performed on his whole flock, and that not one of them died. A ſcratch was made in the ſkin of the right hind leg, three or four inches from the hoof, and a ſmall drop of matter ſqueezed from a ripe puſtule was rubbed into the wound. A plaſter an inch and a quarter long, and an inch broad, was then applied over it. Profeſſor Beckmann, to whom we are indebted for this article, ſays he does not know whether it has been proved by experience that ſheep inoculated in this manner are ſecured againſt future infection. This point indeed does not ſeem to be yet determined; otherwiſe, the Royal Society of Gottingen would not have made it the ſubject of a prize queſtion.

DEATHS.

On the 16th of February, at Munich, of a ſtroke of the apoplexy, Charles Theodore, elector Palatine, who as a friend to the arts and ſciences deſerves a conſpicuous place in the annals of literature. A chronological catalogue of his inſtitutions may be found in F. P. Wundts *Eſſay towards a general Hiſtory of the Palatinate of the Rhine.* In the year 1763 he founded the Academy of Sciences at Manheim, which ſince its eſtabliſhment has certainly been of great utility by its reſearches into ancient hiſtory and geography. At the ſame time that the Academy was founded, a Cabinet of Antiquities was begun. In 1769 the Phyſical Economical Society at Lautern was eſtabliſhed; and in 1774 the High School, which in 1784 was transferred to Heidelberg and united with the Univerſity of that place. The German Literary Society at Manheim eſtabliſhed in 1775 was founded alſo by this Prince, as well as the Cabinet of Natural Curioſities begun in 1765; the Botanical Garden; the Military

Military Anatomical Theatre; the Chirurgical College; the School of Midwifery, and the School for attending on the Sick. He augmented the Court Library at Manheim with the ſcarceſt and moſt valuable works; expended conſiderable ſums on the Obſervatory of that city, and raiſed it to be one of the firſt not only in Germany but in Europe. To encourage and promote the fine arts, he eſtabliſhed in 1775 the Academy of Drawing and Sculpture at Manheim, a Hall for copying Paintings with a valuable collection of pictures, and the German National Theatre, which, by the zeal of M. von Dalberg and the talents of excellent performers, ſoon became one of the moſt celebrated in Germany.

On the 2d of April, at Lizieux in Normandy, Charles Lemonnier, the oldeſt of the contemporary French aſtronomers. He was born on the 20th of November 1715, and had a great ſhare in the expedition undertaken in 1735 for meaſuring a degree of the meridian in the north.

TO THE EDITOR OF THE PHILOSOPHICAL MAGAZINE.

SIR,

IN a collection of minerals in my poſſeſſion there are ſeveral ſpecimens which I ſuſpect to contain Mr. Klaproth's new ſemi-metal uranite; but as they are handſome, and not large, am unwilling to ſacrifice them to analyſis to know their contents.

If any of your mineralogical readers can, through the channel of your uſeful Magazine, point out by what means the preſence of uranite can be aſcertained in ſuch ſmall pieces only as can be detached from cabinet ſpecimens, I ſhall be much obliged to him.

By giving this a place in your next Number, you will oblige one who wiſhes every ſucceſs to the Philoſophical Magazine.

June 15, 1799. A. B.

THE

PHILOSOPHICAL MAGAZINE.

JULY 1799.

I. *On the Longitudinal Vibrations of Strings and Rods, with Observations on the Conveyance of Sound through solid Bodies. By Dr.* CHLADNI *of Wittemberg**.

PHILOSOPHERS formerly were acquainted only with the longitudinal vibrations of the air in a sounding pipe, where, as is well known, the pipe or tube itself is not the sonorous body, but the column of air contained in it, which, according to the direction of its length, contracts and expands in various ways. That solid bodies also can vibrate in the direction of their length, according to the same laws, as the above elastic fluid in a pipe; and that the laws of this longitudinal vibration are totally different from those of transversal vibration, I first shewed in regard to strings in my discoveries respecting the Theory of Sound †, and in regard to rods in my work on the Longitudinal Vibrations of Strings and

* Extracted from his work on that subject, entitled, *Ueber Longitudinalschwingungen der Saiten und Stäbe. Nebst beygefügten bemerkungen über die Fortleitung des Schalles durch feste Körper.*

† Entdeckungen über die Theorie des Klanges, p. 76. See also *Berliner Musikalischen Monatschrift.* August 1792.

Rods. A ſtring can extend and contract itſelf either wholly in the direction of its length, or divide itſelf into two, three, four, or more parts, each of which is ſubject to a movement of the like kind. The tones, which in compariſon of the tranſverſal tones are exceedingly high, are to each other as the numbers 1, 2, 3, 4, &c., or as the number of the vibrating parts. They ſo far correſpond with the tranſverſal tones, that in the ſame kind of vibration they are in the inverſe ratio of the length of the ſtrings; but totally differ from them in this, that the thickneſs and extenſion of the ſtring are of no account, and that, for this reaſon, more depends upon the nature of the ſubſtance. Thus the tone of a braſs ſtring is about a ſixth or a ſeventh higher than the tone of a cat-gut ſtring; and the tone of a ſteel ſtring is a fourth or nearly a fifth higher than the tone of a braſs ſtring. On the other hand, in the tranſverſal vibrations of a ſtring, the tone, as is well known, does not depend on the quality of the ſubſtance, but on the length, weight, and degree of tenſion. A ſtring, therefore, which vibrates longitudinally, is not to be conſidered ſo much as a thread-like body rendered elaſtic by tenſion, but as a piece of matter extended in length, and which vibrates exactly in the ſame manner as a rod or ſtaff faſtened at both ends. When a ſtaff is free at both ends, in its firſt manner of longitudinal vibration, there is a certain point in the middle at which the vibrations of each half ſtop; in the next there are two, each at the diſtance of a fourth part from the end; and in the following there are three, &c. The tones correſpond with the natural ſeries of the numbers 1, 2, 3, 4, &c. If a rod be faſtened at one end during the firſt kind of longitudinal vibration, the alternate expanſion and contraction of the whole rod take place in ſuch a manner that they ſtop at the fixed end; in the next tone there is a reſting point at the diſtance of one-third from the free end; and in the following there are two, &c. The tones correſpond with the numbers 1, 3, 5, 7, &c., and the firſt of theſe tones is an octave lower than the

the firſt tone of the ſame rod when perfectly free. All kinds of longitudinal vibrations can be beſt produced by proper friction or rubbing in the direction of the length with the finger, or any ſoft ſubſtance rubbed over with pounded reſin, and on glaſs rods, of which thoſe uſed for thermometers and barometers are the fitteſt, with a wet rag beſtrewed with fine ſand; from which it is evident that the rubbing muſt be performed within a vibrating part, and that the rod muſt be gently held between two fingers of the other hand at any of the reſting points, but at no other place. In pipes the higher tones are produced by a ſtronger and ſomewhat different method of blowing. In a pipe open at both ends, the column of air contained in it vibrates like a rod free at both ends; and the column in a pipe cloſe at one end, like a rod which is fixed at one end. In all longitudinal vibrations, the tones, during the ſame kind of vibration, depend merely on the length of the ſonorous body, and on the quality of the ſubſtance: the thickneſs, and other circumſtances in regard to form, are of no conſideration. I have examined every ſubſtance which I could obtain in a ſufficiently long rod-like form, in regard to longitudinal vibration; for example, many kinds of wood and metal, alſo glaſs, whalebone, &c. The ſpecific gravity makes no difference; for fir-wood, glaſs, and iron, give almoſt the ſame tone, as alſo braſs, oak, and the ſhanks of tobacco-pipes made of clay.

As ſound is conducted alſo by longitudinal vibrations, ſince a portion of air, or of any other ſubſtance, is obliged by the impulſe of the ſonorous body to contract and again expand itſelf, a more accurate knowledge of longitudinal vibration may ſerve to determine with what velocity ſound is conducted through hard bodies. Count Giordano Riccati, in his excellent work on Strings or Elaſtic Fibres*, has proved that ſound paſſes through a ſpace filled with air, of a given length,

* Delle Corde ovvero Fibre Elaſtiche. Bologna, 1764. 4. Sched. v. § 3. and Sched. viii. diſt. 1.

in the ſame time that a column of air of the ſame length, contained in a pipe open at both ends, makes one vibration. Newton in his *Principia** ſays the ſame thing in another manner, for he aſſerts that each ſtroke *(pulſus)* paſſes through twice the length of an open pipe; but he calls a double vibration, that is, a contraction and expanſion, a ſtroke; whereas Riccati and others, agreeably to the common mode of expreſſion, call each contraction, as well as each expanſion, a vibration. The principles on which this propoſition depends, ſeem to be of ſuch a general nature that they may be applied to hard bodies; and thus we may at leaſt admit, with the greateſt probability, that ſound paſſes through every body in the ſame time in which that body, when it vibrates freely, makes one longitudinal vibration. We are taught by experience, that ſound moves through the air with a velocity of about 1040 Paris feet in a ſecond; we learn alſo from experiments and calculation, that in a ſhut pipe of five feet, and an open pipe of ten feet, 100 vibrations are made in a ſecond. According, then, to the above propoſition, ſound muſt paſs through ten times a hundred, that is, 1000 feet in a ſecond. That the velocity is ſomewhat greater, being about 1040 feet, does not however contradict the propoſition; for the column of air actually agitated by the ſounding of a pipe, is always a little longer than that contained in the pipe; as Count Riccati has proved in the before-mentioned work, and as people may be eaſily convinced through experience, by holding the hand cloſe to the mouth of a pipe, where the vibration of the air will be ſtrongly felt. Hard bodies, if the above propoſition be univerſally true, muſt conduct ſound with greater velocity in proportion as the tone is higher, which is emitted by the ſame length and with the ſame kind of longitudinal vibration. Now the tones of a rod of tin are about two octaves and a large ſeventh higher; one of ſilver, three octaves and a whole tone; one of copper, nearly three octaves and a

* Princ. Philoſ. Nat. lib. ii. prop. 50. in ſchol.

fifth;

fifth; and one of iron or glafs, about four octaves and a half tone higher than the column of air in an open pipe of the fame length. If one therefore had a fufficiently long feries of fuch fubftances, the velocity with which found is conveyed through tin would be found to be 7800, through filver 9300, through copper 12,500, through glafs and iron 17,500 Paris feet in a fecond. The kinds of wood I have examined would conduct found from about 11,000 to nearly 18,000, and burnt pipe clay from about 10,000 to 12,000 feet in a fecond.

Profeffor Wünfch, in fome papers which he read before the Academy of Berlin* in 1788 and 1789, made known experiments to which he was led by Hook's Micrographia, and from which he infers, that found moves with infinite velocity through hard bodies, or with the fame velocity as light. It follows, however, from the experiments which were made with a feries of wooden laths not of confiderable length, that found was conducted through thefe fooner than through the air.

Hard bodies, in regard to the ftrength with which they convey found, feem to exceed air; fo that we may confequently admit that air, though the moft common conductor of found, is however one of the worft conductors of it. If a man holds one end of a ftick in his teeth, and applies the other to a founding body, he will clearly hear the found of it though his ears be ftopped; and in this manner two perfons, almoft deaf, could hear all the notes of my euphon †, even in pianiffimo ‡. If one holds between the teeth a thread, to the end

* Berlin 1793-4.

† For an account of the Euphon fee Phil. Magazine, Vol. II. p. 391.

‡ About fifty years ago a merchant at Cleves named Joriffen, who had become almoft totally deaf, fitting one day near a harpfichord while fome one was playing, and having a tobacco-pipe in his mouth, the bowl of which refted accidentally againft the body of the inftrument, he was agreeably and unexpectedly furprifed to hear all the tones in the moft diftinct manner. By a little reflection and practice he again obtained the ufe of

end of which is ſuſpended a large ſilver ſpoon, and beats it againſt any thing, he will hear a noiſe, even if his ears are ſhut, equal to that of a large bell. Perolle has given excellent obſervations on the capability of hard bodies to conduct ſound, in the Memoirs of the Academy of Turin for 1790 and 1791. Articulated tones alſo are conducted exceedingly well through hard bodies, as I found by experiments which I made with ſome of my friends. Two perſons who had ſtopped their ears could converſe with each other when they held a long ſtick, or a ſeries of ſticks, between their teeth, or reſted their teeth againſt them. It is all the ſame whether the perſon who ſpeaks reſts the ſtick againſt his throat or his breaſt, or when one reſts the ſtick which he holds in his teeth againſt ſome veſſel into which the other ſpeaks. The effect will be greater the more the veſſel is capable of a tremulous movement. It appeared to be ſtrongeſt with glaſs and porcelain veſſels; with copper kettles, wooden boxes, and earthen pots, it was weaker. Sticks of glaſs and next fir-wood conducted the ſound beſt. The ſound could alſo be heard when a thread was held between the teeth by both,

this valuable ſenſe, which, as Bonnet ſays, connects us with the moral world; for he ſoon learned, by means of a piece of hard wood, one end of which he placed againſt his teeth, while another perſon placed the other end in the like manner, to keep up a converſation, and to be able to underſtand the leaſt whiſper. His ſon made this beneficial diſcovery the ſubject of an inaugural diſſertation under the following title: "*Diſſertatio medica ſiſtens novi methodi ſurdos reddendi audientes phyſicas et medicas rationes.* Præſ. Andr. El. Buchnero; auct. Jo. Jorissen. Halæ, 1757. 4. One hears moſt diſtinctly when the end of the ſtick reſts againſt the upper fore-teeth, or rather when it is held between the teeth: if placed only againſt the lower teeth, it will be of no avail. The natural cauſes of this and many other variations which the author and his father tried, are explained in the above uſeful Tract, which was afterwards publiſhed in German, by the preſident, with the title of, *Büchners Abhandlung von einer beſondern und leichten art Taube hörend Zu Machen: Nebſt andern Anmerkungen. 1re Samml.* Halle 1759. 8.—[This note is by Profeſſor Blumenbach. Edit.]

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ſo as to be ſomewhat ſtretched. Through each ſubſtance the ſound was modified in a manner a little different. By reſting a ſtick or other body againſt the temples, the forehead, and the external cartilaginous part of the ear, ſound is conveyed to the interior organs of hearing, as will readily appear if you hold your watch to theſe parts of another perſon who has ſtopped up his ears. From this it appears, as well as from many known experiments made in regard to hearing under water, that in moſt of our books on the elements of phyſics, in which in general accouſtics have had the undeſerved fate of being treated in a much more imperfect manner than other parts of philoſophy, ſound is very improperly conſidered only as a vibration of the air, and the theory of it referred to the head of Air. Hearing is nothing elſe than, by means of the organs of hearing, to be ſenſible of the tremulous movement of an elaſtic body, whether this tremulous movement be conveyed through the air, or any other fluid or hard body, to the auricular nerves. It is alſo eſſentially the ſame whether, as is uſually the caſe, the ſound be conveyed through the internal part of the ear, or whether it be communicated through any other part of the body. It certainly would be worth the trouble to make experiments to try whether it might not be poſſible that deaf and dumb people, when the deficiency lies only in the external organs of the ear, the auricular nerve being perfect, could not, by the above method of conducting ſound, be made to hear diſtinctly words articulated as well as other ſounds.

II. *Obſervations on the true Origin of the Goſſamer.* *By* J. M. Bechstein*.

To explain the origin of the goſſamer is an old problem, which, after a number of experiments, no one, as far as I know, has yet fully ſolved. Some naturaliſts have conſidered

* From *Magazin für das Neueſte aus der Phyſik.* Vol. VI. Part I. p. 53.

this phenomenon as the evaporation of plants condenſed during the cool days of harveſt by the air, and converted into threads like thoſe which can be drawn from reſinous juices; others, as the production of a kind of ſpider, on account of its ſimilarity to the threads of common ſpiders*: and M. D. C. Pereboom has lately diſcovered a kind of beetle furniſhed with a veſicle on its back, from the hinder part of which, on both ſides, proceed two threads that extend over the extremity of the body, and end in a double thread, ſometimes ten or more ells in length; and this thread is ſuppoſed to be what is commonly called the Goſſamer.

After many years experience and obſervations made almoſt daily when this phenomenon appeared, I flatter myſelf that

* In the country, during autumn, certain threads are ſeen hanging from the trees, or extended on the buſhes, and even the graſs, which, when agitated by the wind, detach themſelves from the branches, are tranſported to others, and are joined or ſeparated at the pleaſure of the breeze. People in walking often find their faces, hair, and clothes, covered with them. They are generally called the threads of St. Martin *(fils de St. Martin)*, becauſe it is about St. Martin's day that they appear in the greateſt abundance. When the moiſture of the atmoſphere and the dew attach themſelves to theſe threads and become congealed, ſo that the threads appear thicker and whiter, the peaſants call them the hair of the Virgin Mary *(cheveux de la Vierge Marie)*. Having one day aſked them the cauſe of this production, they unanimouſly replied, and without variation, that it was the vapours of the earth, which at that ſeaſon are thicker and denſer. I had no great confidence in this opinion: but I ſoon learned the real truth; for, being in a field overſpread with heath in the time of autumn, I obſerved that almoſt all the heath-buſhes were covered with ſpiders webs, and when theſe were opened I found incloſed in each a ſpider. Theſe ſpiders were ſmall, of a red colour, and marked with ſpots; their feet were ſhort, and the head was large in proportion to the belly. Such ſpiders webs are found among the low ſhrubs that grow near the earth, at the bottom of ſtalks of corn which have been left ſtanding by the reapers, and in the buſhes. When the wind is ſtrong it breaks theſe webs, carries away a part of them, which are ſcattered over the ground and the trees, and hence come the threads of St. Martin. *Huetiana*, Amſterdam 1723, p. 369. EDIT.

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I am able to reſolve the problem reſpecting its origin. In my opinion the goſſamer ariſes from nothing elſe than a certain kind of field-ſpiders, which are, however, ſo ſmall and active, that they almoſt always eſcape notice, unleſs the obſerver is endowed with great acuteneſs of ſight. I would call this ſpider, if it has already no name, the goſſamer ſpider *(aranea obtextrix)*: I ſhall here give a ſhort deſcription and hiſtory of it, as far as my knowledge extends.

The goſſamer ſpider *(aranea obtextrix)* is as large as the head of a ſmall pin. On the fore-part of its longiſh head it has eight grey eyes placed in a circular form; the extremity of the body is ſhaped like an egg; the body itſelf is of a ſhining dark-brown colour; the feet are of a moderate length, and yellowiſh; and the whole animal is covered with inſulated hairs.

Theſe inſects firſt appear in the beginning of October, in woods, gardens, and meadows, where their eggs may be hatched unhurt and unmoleſted, and thence ſpread themſelves over whole diſtricts, ſo that during all the month of October and till the middle of November they may be found on the dry fields throughout all Europe; and as they produce a numerous progeny, extenſive tracts may ſometimes be ſeen ſwarming with them. The young, which have not attained to their full growth, are not larger than the point of a pin; they are black, with grey feet, and almoſt imperceptible to the naked eye. In the beginning of October, when very few of them have been hatched, one obſerves only in the ſunſhine a few ſingle threads of their webs, which they extend from twig to twig, or from ſtraw to ſtraw; but about the middle of the month their threads become more perceptible; and towards the end, if people ſtand or place themſelves in ſuch a poſition that they can ſee the ſun-beams playing on the tender threads, they perceive hedges, meadows, corn-fields, ſtubble land, and even whole diſtricts, covered with a fine white thick ſort of gauze. This ſpider belongs to that kind which do not weave webs, but only extend ſingle threads

threads from one place to another, and which Linnæus, on that account, includes in a particular diviſion. The threads, owing to the ſmallneſs of the animal, are ſo delicate that a ſingle one cannot be diſtinguiſhed by the naked eye unleſs when the ſun ſhines upon it. A thread, to be viſible at other times, muſt be compoſed of at leaſt ſix threads twiſted together; and ſuch a thread, as the ſingle ones are exceedingly brittle and do not readily unite, may be again eaſily divided into its component threads. During the ſerene calm days of the above months theſe animals carry on their occupation with great diligence, eſpecially after the morning fogs have diſappeared. Between the hours of twelve and two, however, is the period when their great induſtry excites moſt admiration. If people are poſſeſſed of good eye-ſight, or are furniſhed with a magnifying glaſs, they may find among the barley ſtubble ſuch a multitude of theſe ſpiders employed in extending their threads, that the fields appear as if covered with ſwarms of gnats, and they perform their labour ſo ſpeedily that they ſeem to fly from one ſtubble to another.

Theſe tender threads, which are extended over whole fields, particularly in the laſt half of October, become twiſted together by the gentleſt breath of wind, and form perceptible threads, that, being broken looſe by a ſtronger wind, are united into thick threads, and even balls, that float through the atmoſphere. They are known then in Germany by the name of the *flying ſummer* *, becauſe the ſummer ſeems as it were to fly away at the ſame time. The ſpiders alſo are then conveyed along in them; and it is not uncommon to find theſe animals entwiſted in ſuch threads which have been caught †.

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* In German *fliegende ſommer*.

† A ſingular uſe which ſome kinds of ſpiders make of their webs is, that they ſerve them inſtead of carriages to perform long journies, and to tranſport themſelves from one country to another. At certain times of the year we may generally ſee, when the ſky is ſerene, a multitude of ſtrong threads and balls formed of the threads of theſe inſects, floating about in the atmoſphere;

All the ſpiders, however, found in theſe threads or balls, muſt not be conſidered as the animals by which they were prepared; for other kinds of ſpiders, common in harveſt, are ſometimes entangled in theſe threads and carried along with them. Thus, for example, the black and white ſpotted tree-ſpider, and the ſo called cheſtnut-ſpider, are often found incloſed in the goſſamer together with their habitations, and muſt obey the impulſe of the winds.

Theſe webs, which conſiſt of threads cloſely joined together, ſerve the inſects as nets, in which they catch very ſmall black flies, gnats, and winged tree-lice, the juices of which they ſuck for their nouriſhment. The goſſamer, therefore, is often found filled with the dried huſks of ſuch inſects.

The above, in my opinion, is the real origin of the goſſamer. But why do theſe ſpiders appear only in the time of harveſt? why not earlier? and why are they not found like the houſe and field-ſpiders throughout the whole ſummer? —Theſe objections obviate themſelves. They appear at that period for the ſame reaſon that may-bugs *(maykaffer)* appear in the month of May. They are as neceſſary in their order to preſerve the equilibrium of the balance of Nature as the may-bugs are in May. Single ſpiders of this kind, however, may be found the whole ſummer through, as ſingle may-bugs are found in harveſt. To thoſe who know that exactly about this time thoſe birds, for whoſe nouriſhment inſects have been aſſigned, undertake their emigrations, and that the larks in particular, which are ſo fond of ſpiders, then leave us, the above phenomenon will not appear wonderful, but will rather be conſidered as a wiſe regulation of Nature. Thoſe who wiſh to be convinced of the truth of this obſervation need only to ſhoot a lark at that period and to open it imme-

ſphere; and when theſe threads and balls are examined, they will always be found to contain ſpiders, which have prepared theſe ſubſtances to enable them to fly without wings, and to procure themſelves an eaſy paſſage to other countries. *Théologie des Inſectes par Leſſer, avec des Remarques de P. Lyonnet.* A la Haye, 1742. Vol. I. p. 346. Edit.

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diately. Theſe inſects, together with the grains of barley which drop from the ears, muſt indemnify theſe birds, which ſtop in many places on their paſſage in great numbers, for the loſs of the ſummer inſects.

After what has been ſaid, I do not think that the whiteneſs of the threads, which ariſes from nothing elſe than the dews that fall at that period, or their clammineſs when rubbed between the fingers, not obſerved in the threads of other ſpiders, and which is occaſioned by the fineneſs of the threads, that ſo eaſily inſinuate themſelves into the cavites of the ſkin, can be brought as any objection againſt this mode of explanation. Theſe phenomena can have no weight unleſs we aſcribe theſe threads to the common ſpider. It is likewiſe very improbable that the goſſamer is produced, as M. Pereboom aſſerts, by his beetle; which however muſt excite our admiration, becauſe, like the ſpider, it weaves for itſelf a net, either to ſerve it as a habitation, or as the means of catching its prey.

III. *Remarks on Mr.* SHELDRAKE'S *Diſſertation on Painting in Oil in the Manner of the Venetians. By Mr.* EDWARD DAYES. *Communicated by the Author.*

PERSUADED that Mr. Sheldrake labours under a miſtake, which may lead others into a practice difficult in itſelf and dangerous to the durability of their works, I ſhall offer no apology for the following remarks on his Diſſertation *.

That the Venetians primed with diſtemper, is true; but the colour uſed was not a *brown*, as ſtated by Mr. Sheldrake, but a *red*, known at preſent by the name of *Venetian red*. Some artiſts at this time employ the ſame colour, previouſly calcined, in a new Venetian method: I ſay a new one, for there are two or three. One of the ſecrets conſiſts in prim-

* See Phil. Mag. Vol. II. p. 302.

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ing the cloth with bone-aſhes, mixed with a ſmall quantity of ſize or paſte, and afterwards bruſhing it over with the above calcined-red.

The method of working up the picture in a ſtate of black and white was certainly practiſed at times by ſome of the Venetians; but in that caſe the ground was no object, as the whole effect of colour was afterwards acquired by glazing: this is obſervable in the pictures of Tintoret, and ſufficiently accounts for the periſhed ſtate they appear under. On the contrary, where the red ground was uſed, the light and extreme dark are the only part where the colour lays in a body. Mr. Sheldrake obſerves, he does "not pretend to degrade painting to the rank of a mechanical art, that may be infallibly practiſed by a receipt." If the Venetians had poſſeſſed no higher recommendation to notice than mere colouring, they would not have ſo ſtrongly arreſted our attention; on the contrary, the compoſitions of Titian, Paul Veroneſe, &c. will ever rank among the firſt. The preſent rage for colour is like preferring perſon to mind, and had it prevailed in the time of Swift, would certainly have procured ſome of our profeſſors a ſituation at Lagoda.

The author of the Diſſertation muſt certainly have miſtaken the words of Sir Joſhua, or not underſtood them. Sir Joſhua could never have ſaid that harmony was to be produced by "an unity of light and an unity of ſhadow pervading the whole;" or, in other words, (as I underſtand it,) by reducing the whole of the lights to one colour, as is implied by the word *unity*. Such a practice would deſtroy the brilliancy which the author wiſhes to obtain from glazing. The ſimile afterwards introduced, contradicts entirely ſuch an inference. "A picture, to poſſeſs harmony of colouring, ſhould look as if it was painted with one colour; and, when the *chiaro-oſcuro* was complete, the colour of each object ſhould be glazed over it." Sir Joſhua was in the ſimile deſcribing his own practice, and which will, for a ſhort time, produce a greater brilliancy in the light. Inſtead of an

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"*unity* of *light*," the word *harmony* muſt have been uſed, as harmony of light and unity of ſhade are common terms. In note 43, on Du Freſnoy's Art of Painting, he (Sir Joſhua) expreſsly ſays: "And for the ſake of harmony, the colours, however diſtinguiſhed in their light, ſhould be nearly of the ſame colour in their ſhadows, of a

——— "ſimple unity of ſhade,
"As all were from one ſingle palette ſpread."

Every one knows that the harmony of the picture depends greatly on the ſhadows not being diſturbed with colour. That Sir Joſhua was acquainted with the method of bringing forward his pictures in a ſtate of black and white, and glazing for the colours even in his draperies, is too true, as is known to all acquainted with his practice, and was, I believe, the reaſon of their not ſtanding. His method was, with ivory black, vermilion (uſed in the carnations), and white, to bring forward his pictures to their full effect, and then to glaze for all the colours. It ſhould be obſerved, that this method might only be practiſed at times, but I had myſelf ſeveral opportunities of ſeeing it.

All the advantages obtained by the practice of glazing, as it is called, are ſo tranſitory, that they may be literally ſaid to be but the viſion of a day. Whether this ariſes from the gum in what is termed maguilp *, (a compoſition of two parts maſtic varniſh and one of drying oil,) moſtly employed for the purpoſe, or want of body of colour, I do not pretend to determine, though I think both may contribute to effect their deſtruction; the colour by flying off, and the gum by

* The above compoſition, when mixed on the palette, forms a conſiſtence like honey, with which the colours work exceedingly free. There are various compoſitions for maguilps; ſome uſing wax diſſolved in nut oil, others roſin and ſugar of lead in the ſame ſolvent, wax in ſpirits of turpentine, &c.: though I muſt own a preference for the drying oil and varniſh for diluting the colours for the touches or pluming on a part, but for the mere act of glazing I prefer good clear oil.

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loſing its tranſparency. One thing I have frequently had occaſion to remark in the uſe of water colours (in a tranſparent ſtate), that the more gum is mixed with them, the ſooner they fly. As far as glazing goes to enrich a colour it is neceſſary; but that is a very different practice from the one I now ſpeak of.

Many ſubſtances employed as pigments give black, or dead, heavy colours; as Pruſſian blue, indigo, dark lake, and indeed all colours that are tranſparent when viewed in a lump; but, ſpread on a white ground, or mixed with any colourleſs matter, they appear in all their vigour. If, inſtead of a white ground, a grey or brown is uſed, the vivacity will be more or leſs in proportion to its darkneſs. Theſe facts furniſh ſtrong reaſons for preferring a white ground, and may account for the darkneſs in many of the Venetian pictures, from their glazing with tranſparent colours on a dark ſurface, and, as before ſtated, the loſs of clearneſs in the vehicle uſed (no doubt a gum); but this appears to have been only an occaſional practice.

The Dutch painters, whoſe mechanical excellence was inferior to none, always uſed white grounds prepared with the greateſt care. They ſpread well-waſhed chalk mixed with ſize over the ſurface to be painted on, which if nicety was required they pumiced, and repeated the operation till the ſurface was even; after which they laid over it a coat of the fineſt flake white. The whole picture was then painted fair, (that is, with a body of colour,) except the ſhades, which were kept clear and tranſparent, and received an additional luſtre from the ground. That this was their practice may be eaſily ſeen in all their interior ſcenes and the cloſe parts of their pictures.

It is much to be wiſhed that, inſtead of brilliancy, *permanency were ſought after*; while the Venetian pictures are going faſt to decay, the works of Van Eyck, Quintin Matſys, and John de Mabuſe, remain freſh and vigorous.

With reſpect to ſhadow being a privation of light, it is

readily admitted, and it equally follows, that it is a privation of colour; but this circumſtance ſhews, as before ſtated, that much of the harmony of the picture muſt depend on its not being diſturbed with colour. Where Mr. Sheldrake attempts to illuſtrate this doctrine, by ſuppoſing a globe expoſed in a painter's room, he ſeems rather to have confuſed the matter by too many diviſions. Artiſts divide the ſurface of all bodies into light, middle tint, ſhadow, and (which Mr. Sheldrake has forgot to add to his globe, to round it) reflection. There are two things the author of the diſſertation appears to have overlooked, and which eaſes the difficulty of producing the harmony neceſſary to conſtitute a whole: firſt, the method (ſaid to have been at firſt practiſed by the Venetians) of breaking the colours, ſo as to make them all partake in ſome meaſure of each other, and which was at times carried to a degree of inſipidity even by Titian; and ſecondly, (and which I think the moſt eſſential,) the grouping the warm colours together ſo as to form a maſs, and letting them occupy the greateſt portion of the picture. The latter appears to have been the practice of Rubens and others of his ſchool, and which enabled him to introduce the whole ſcale of colours in the ſame picture, from the hotteſt to the oppoſite extreme of cold; this gives a vigour to his colouring beyond all other maſters.

The method of working up the picture in a ſtate of black and white, was certainly never practiſed by the Flemiſh maſters. The beauty obſervable in the colouring of Rubens (whoſe demi-tints are wonderfully clear) reſulted from a firmneſs in the handling, a ſimplicity and diſtinctneſs in the tints, and a particular care to avoid muddling them in uſing: I do not mean to ſay they never glazed, or ſcumbled to give richneſs; but that was done in a different manner to the one deſcribed in the Diſſertation. In ſome of his ſlight pictures the tones in the fleſh may be traced as follows: the light yellow, next the carnations, then the grey, next the ſhadow, glazed to give it clearneſs, and his reflections generally very bright;

bright; but in his finiſhed works they are of courſe more blended. Every artiſt knows, or ought to know, that there are but three primary colours, red, blue, and yellow; the compound colours, which reſult from combining theſe, amount to four, making in all ſeven. Red and blue, when mixed, produce purple; red with yellow, orange; blue and yellow, green; the three united, a brown, black, or grey, as the warm or cold colours prevail. Thoſe conſtitute all the colours and tints in nature, mixed with more or leſs white. The fewer colours uſed by the artiſt the better he will colour, from the practice being rendered ſimple, and the poſſibility of muddling in ſome meaſure deſtroyed: for, *it is not the mixing colours that hurts, but the mixing many*; two colours will always be clearer than three, and ſo on. Though the above conſiderations offer a ſimple theory of colouring, yet in practice the artiſt muſt have judgment enough to acquire at once the preciſe tint he wants, to inſure clearneſs and brilliancy. The ſingular fact of white appearing grey on a brown ground, I ſhould ſuppoſe to ariſe from white being cold, and from its contraſt with the brown. That a picture painted in brown and white ſhould be in perfect harmony is not to be wondered at, as it can only be termed an effect of light and ſhade. The brown uſed by the Venetians has, with great probability, been ſuppoſed a preparation of aſphaltum.

As the practice of glazing is the laſt operation in painting, and as in the doing it the artiſt uſes in the ſhadows ſome tranſparent dark colours, it of courſe follows, thoſe ſhadows muſt be kept tenderer to receive the glaze, which may be extended to the demi-tints if kept tender in proportion alſo: this will produce the deceptive appearance Mr. Sheldrake ſpeaks of in the Venetian pictures, and do away the weight reſulting from mixing, as he ſays, "ſome duſky colour with the local colours and the light." The above method, with the practice of ſcumbling on the lights, or

merely enriching a colour by glazing, in my opinion sufficiently accounts for Venetian brilliancy.

What is meant by black and white not being the painter's extreme of light and dark, I profess not to understand: all that I know is, that the artists have to lament, as well as Mr. Sheldrake, the being obliged to represent shadow with a substance, and that even glazing them thin is but a poor imitation of the real appearance. With respect to "the painter's art being to represent objects as they appear, in point of colour, to be not as they really are," I am equally at a loss to understand the author, having ever been taught to consider all colour as comparative; and therefore, that black at 50 feet distance was no longer so, and to call it black would be as absurd as to call twilight night.

If I judge right, (from the author's recapitulation,) there are three stages in his process; first, the darkest tints, then the lights, and lastly the colouring. Now I think it is evident, from the oil being instantly absorbed by the ground, that it would be utterly impossible to blend the lights and darks together so as to make the picture mellow. Then comes the glazing for the colours, which is bad, as experience has sufficiently shewn the want of durability: besides, for such a process, oil makes the colours too thin to work: this made the artists resort to the expedient of using maguilp, which has the injurious tendency before stated. What made these artists so desirous of a clearness in the shades, was to give them that non-substantial appearance Nature puts on: in his lights, it is true, the artist wants brilliancy, to acquire which he occasionally glazes or scumbles; but every good artist knows, that the less recourse he has to the former practice, the more permanent his picture will be.

After all the consideration I have been able to give this subject, I am inclined to think that the Venetian method, judging from a picture by Tintoret now before me, was more like that followed by Sir Joshua Reynolds, as above described,

ſcribed, than the one recommended by Mr. Sheldrake. *Titian glazed on colour, Tintoret often on white*; and I think it will invariably be found, that the works of the latter are more periſhed than the former. That exquiſite lightneſs attendant on a dead colouring, may, in a great meaſure, be reſtored by ſcumbling.

The plan he has propoſed, and which ſeems to have been reſorted to, to remove the practical difficulties he met with, is merely to paint in varniſh; a method which always gives brightneſs for a ſhort time. The objections to its adoption may be ſummed up in a few words: firſt, the difficulty of blending the colours uſed to produce the effect of light and ſhade; and ſecondly, (which is by far the moſt material,) the want of durability in the colours, as they muſt all be acquired by glazing; not to mention the ſtrong ſimilitude between it and Sir Joſhua's method, as above deſcribed.

As I never bought Miſs Provis's ſecret, I cannot tell how cloſe the approximation may be between her method and the one propoſed by Mr. Sheldrake; but if I may judge from practical experience, they would both be productive of hardneſs; and as ſome of the colours in the pictures painted after her method carried evident marks of deſtruction on them, I was immediately induced to ſuppoſe that ſome calcareous earth was uſed in the ground *. Though I much queſtion the utility of Mr. Sheldrake's plan, I think he unqueſtionably deſerves the thanks of the public, and of artiſts in particular, for the time and trouble he has beſtowed on it.

* Lime and terra ponderoſa deſtroy the colouring matter of Pruſſian blue; ſome drawings, hung up in a houſe that had undergone a conſiderable repair, loſt all their blue colour, which had become a dirty iron grey.

IV. *Progreſs of Dr.* MITCHILL's *Mind in inveſtigating the Cauſe of the Peſtilential Diſtempers which viſit the Cities of America in Summer and Autumn. Being a Developement of his Theory of Peſtilential Fluids, as publiſhed to the World in* 1795 *and the ſucceeding Years.*

[Concluded from Page 43.]

WHILE theſe inquiries were making, a memorable diſpute was carried on in ſome of the Atlantic cities, Whether the exciting cauſe of yellow fever was of domeſtic origin, or imported from foreign places in ſhips and merchandize? The prevailing opinion at New-York was, that there were local cauſes enough for the production of that diſtemper in the city itſelf. With the intention of removing the cauſes of this plague from the town, the Legiſlature, then ſitting at Albany, 160 miles diſtant, rapidly paſſed a bill prohibitory of certain trades and manufactures within the compact part of the city. The act forbade, among other things, the *manufacture of ſoap and candles* under a heavy penalty, except at definite diſtances from the houſes and ſettlements. The deſcription of citizens engaged in theſe branches of buſineſs preſented immediately a memorial to the Legiſlature for relief on this occaſion, and retained Dr. Mitchill as their counſel to manage the buſineſs of procuring ſome terms of mitigation at the ſeat of Government. In drawing up the argument in favour of his clients, he became more firmly convinced than before, that ſubſtances compoſed of carbone and hydrogene, ſuch as *fat*, *greaſe*, and *oil*, were incapable of yielding peſtilential air; and that the ſubſtances containing *ſepton*, to wit, the *ſkinny*, *lean*, *muſcular*, and *membranous* parts of animals, together with the *blood* and *alimentary fæces*, were the ſubſtances whence unhealthy and noxious exhalations proceeded. From a general and broad induction of facts arranged in the argument employed on that occaſion, it was rendered clear, that the ſubſtances containing

ſepton,

ſepton, and none others, were known to afford peſtilential air. The ſame rule applied to *vegetable productions*, of whatever kind they might be. On this occaſion it was exhibited in evidence, that the perſons who were engaged ſteadily among the *aſhes*, *ſoap*, and *fat* of thoſe manufactories were protected as it were from peſtilential diſeaſes, and fared mightily better than their neighbours.

A part of this doctrine ſoon after received confirmation from Count Berchtold's and Conſul Baldwin's account of the beneficial effects of *oil* in keeping off and relieving the *ſymptoms of the plague* in Aſia, and from the remarkable exemption of the Nantucket whalemen from malignant fevers on their long voyages over every part of the ocean.

From the ſurvey of the facts relative to *alkalis* and *oils*, there could hardly remain a doubt that they acted upon the *acid of peſtilence*, by neutralizing or decompounding it: ſtill, if this acid conſiſted of ſepton and oxygene chemically united during the putrefaction of organized bodies, why did not thoſe elementary ſubſtances, it was aſked, which conſtitute the baſes of azotic and vital airs reſpectively, incorporate in the atmoſphere, where they exiſt in ſtates apparently very favourable to combination? The reaſon appears to be, that after ſepton and oxygene, in their ſeparate forms, have connected themſelves with caloric enough to form diſtinct gaſes, they are repelled thereby to diſtances greater than chemical attraction can reach, and therefore remain ſeparate. This idea, which Dr. Mitchill originally ſtarted, has ſince been confirmed by Citizen Guyton's account of the poſſibility of bringing the baſes of the two airs into chemical union, by compreſſing them with a force equal to ſeveral atmoſpheres; a part of the caloric in ſuch caſes, according to Dr. Darwin's idea, being crowded out after being compelled to quit its hold. Indeed it ſeemed evident that the chief difference between common air and peſtilential air conſiſted merely in this; that in the former, the ſepton with caloric formed azotic air, and the oxygene conſtituted vital air, each

diſtinct from the other; whereas in the latter caſe the ſepton and oxygene are chemically blended with each other, baſe with baſe. The reaſon of their readineſs to unite during the putrefactive proceſs now became evident. The baſes of the two airs ruſhed into union *before* they had attracted caloric enough to turn them to ſimple gaſes, and give them the repellency incidental to that condition.

The venomous and deadly qualities of nitrous acid had been aſcertained by Eagleſield Smith in his experiments upon ſmall animals inoculated with it.

A caſe occurred during Dr. Mitchill's attendance as one of the phyſicians of the New-York Hoſpital, where *fever* appeared to have been brought upon a patient by the nitric acid abſorbed from the decompoſition of a large quantity of red precipitate with which an ulcerated leg had long been dreſſed.

Several inſtances had come to his knowledge, of ſevere diſorder in the alimentary canal, terminating in *dyſentery*, from an accidental drinking of diluted aquafortis.

It immediately ſtruck him, that privies and collections of human ordure had been long noted for containing ſeptic (nitric) acid. The effluvia of privies had in ſeveral inſtances been known to excite dangerous ſickneſs. Many of the articles of diet contained ſepton, and oxygene, in ſome form, always exiſted in the alimentary canal. As the contents of the ſtomach and inteſtines were inanimate, it was exceedingly probable that, in certain caſes of indigeſtion and coſtiveneſs, ſeptic acid might be formed in the cavities of theſe abdominal viſcera; and that irritation and inverſion of the motions of the ſtomach, in ſome forms of *yellow fever*, as well as ſpaſms of the colon, griping pains and teneſmus in ſome of the caſes of *dyſentery*, PROCEEDED FROM THE SAME EXCITING CAUSE.

By an induction of facts from the operation of *neutral ſalts* in theſe kinds of diſtempers, it appeared, that the moſt efficacious and ſalutary were thoſe which are capable of decompoſition

compoſition by *ſeptic acid*, if it exiſted in the inteſtines; and that really, beſides their cathartic effect, they poſſeſſed a power, derived from their *alkaline baſes*, to neutralize that miſchievous and tormenting liquid. From this principle Dr. Mitchill inveſtigated a theory of the *modus operandi* of theſe numerous and important articles of the MATERIA MEDICA.

Frequent inſtances afterwards evinced the juſtneſs of this interpretation; for in the New-York Hoſpital, as well as in private practice, he found watery ſolutions of the carbonates of pot-aſh and ſoda to be moſt excellent anti-dyſenteric remedies, and valuable preſcriptions in the cholera infantum. The adminiſtration of the carbonate of ſoda *in clyſters*, to allay teneſmus, was ſuggeſted to Dr. Mitchill by Dr. Lent, then apothecary of the houſe, and found, on repeated trials, to be a valuable remedy. Dr. Saltonſtall has treated of the application of this principle to explain yellow fever, and Dr. Bay to elucidate dyſentery, in their ſeveral inaugural diſſertations publiſhed in COLUMBIA COLLEGE.

After being called to the Profeſſorſhip of Chemiſtry, Natural Hiſtory, and Agriculture, in that ſeminary, Dr. Mitchill delivered theſe doctrines publicly in his annual courſe of lectures. The diſſertations juſt mentioned ſhew with what zeal and ſucceſs they were diſcuſſed and applied by his hearers. And a circumſtance worthy of notice reſpecting *both* the gentlemen laſt named, is, that they witneſſed and lived through the plagues they have deſcribed.

A general inference from all the phenomena was, that theſe miaſmata or contagions, in all their forms herein contemplated, were violent STIMULANTS, as Brown had originally conjectured.

But the application of this doctrine to AGRICULTURE was not much leſs intereſting than its relation to Medicine. Dr. Mitchill was born in the pariſh of Hempſtead, in Queen's County. His father was a landholder, and culti-

vated his own eſtate, as is common in America. The early part of his life, to the age of ſeventeen years, was paſſed in the country. In the way he was educated, the implements of huſbandry, and the method of uſing them, were familiar to him: he knew the management of the plough and of the ſpade. After the death of his father in 1789, he took poſſeſſion of the family-patrimony, and lived on it as a practical farmer for ſeveral years. His experience and opportunities during this ſeries of agricultural employment, had produced, among other things, a more curious and particular attention to MANURES.

On reviewing his former obſervations, the ſubject preſented itſelf to him under ſeveral new aſpects. The production of *ſeptic acid* among the excrements of animals had been long known: the neutralization and fixation of this was, he thought, one of the principal effects wrought by *alkalies* and *lime*. Inſtead of ſaying, with the generality of modern obſervers, that lime was ſerviceable by its ſeptic or putrefying quality, (an opinion for which there is no plauſible foundation,) Dr. Mitchill became convinced, its principal effect was, to combine with ſeptic acid into calcareous nitre, one of the richeſt of manures; and reſerve this, without volatilization or evaporation, fixed upon the ſoil, to ſtimulate and feed the plants which grow there. Thus wholeſomeneſs and fertility were provided for in the ſame operation. It ſeemed to him alſo, that the deliqueſcent property of the ſeptite of lime enabled it to retain moiſture a long time upon the land, and thereby moſt agreeably ſecured the crop from the pinching of drought.

It was obvious, that if there was much ſeptic venom (oxygenated ſepton) in any field, yard, or region, and no lime or alkali to neutralize it, epizootic diſeaſes among cattle might proceed from it, after the manner of epidemic diſtempers among the human ſpecies. Dews and fogs impregnated with ſeptic acid, appeared the probable exciting cauſes of ſeveral mortal diſorders in neat-cattle, ſheep, and horſes; a conſiderable

conſiderable quantity of ſuch dilute aquafortis being taken into their bodies as they grazed during the night. He thought this was corroborated by the ſymptoms related by Lanciſi to have been obſerved in the cattle ſick of ſuch diſeaſes in Italy.

And it was no leſs plain that *ruſt* and *mildew* in wheat were owing to the ſame cauſe.

The unwholeſomeneſs of certain dews, in certain places and times, was evidently, he believed, to be aſcribed to a portion of ſeptic acid gas, volatilized during the heat of the day, and precipitated with a portion of atmoſpheric water in the cool of the night.

With this branch of the enquiry was connected the whole hiſtory of nitre, and the pits, beds, and caverns wherein it was produced, whether ſpontaneouſly, or by the hand of man. The interpretation of all the facts relative to which amounted to this; that the alkali neutralized the *acid poiſon of putrefaction*.

On looking around, it could not eſcape Dr. Mitchill, that the ſweetening and cleanſing effects of *lime*, *alkaline ley*, and *ſoap*, in DOMESTIC ECONOMY, were now capable of an eaſy and complete explanation. The ſweat, perſpiration, and excreted matter of almoſt every ſort, which rendered clothing, bedding, furniture, and houſes foul, contained ſepton; and conſequently, in the heat of the human body, *ſeptic acid* might be produced in quantity and ſtrength ſufficient to excite many morbid *affections of the ſkin*, and, if abſorbed, engender the *worſt forms of fever*. Lime, ley, and ſoap rendered the human body, its clothes, bedding, &c. pure and wholeſome, by their power of attracting all kind of peſtilential matter, and carrying it clean off. He therefore became ſatisfied that the old maxims of female management were beſt; for he never knew infection break out where there was a SMART WOMAN for a houſekeeper: the reaſon was, ſhe *kept the miſchief down by alkalies*. On the other hand,

hand, wherever MEN, eſpecially thoſe who ſet up for PHILOSOPHERS, took the lead; as in priſons, workhouſes, hoſpitals, and ſhips; there were for ever complaints made of the riſe and progreſs of malignant diſtempers: the reaſon was, they increaſed the evil by acid fumigations *.

Numberleſs inſtances had happened in New-York, of perſons being *poiſoned*, and many of them to death, or, in other words, catching the yellow fever, from the ſeptic vapour of corrupting *beef* and *fiſh* cured with too ſmall a quantity of ſalt. Theſe are moſtly *lean* animal ſubſtances. On their corruption they afford the moſt deadly effluvia. The frequency of ſtinking proviſions of theſe kinds, and of the poiſonous vapours they emitted, led Dr. Mitchill to inveſtigate a theory of the muriate of ſoda in preſerving animal fleſh from putrefaction. The reſult was this: when ſeptic acid is formed in a barrel of beef, the common ſalt is decompoſed; and while the ſeptic acid combines with the ſoda, the muriatic acid is ſet looſe to impregnate and preſerve the meat. When there is too little muriate of ſoda, the ſeptic acid, becoming volatile, often ſickens, and even kills the perſons who are expoſed to it.

This interpretation led naturally to an inquiry into the uſe of the *bile of animals*; which, inſtead of being a *vile*, *troubleſome*, *excrementitious*, and *corruptible* liquor, as it has been faſhionable to term it, turns out to be a grand preſerver of health, by virtue of the *ſoda which it contains*; being always ready to pour itſelf into the duodenum, and even regurgitate into the ſtomach, to neutralize any portion of ſeptic venom which may have been ſwallowed or engendered there. Of all the fluids the animal body contains, the gall is the leaſt liable to corruption, or alteration unfriendly to health.

* The author of the preſent paper was not perhaps aware of the ſtrong evidence in favour of the utility of acid fumigations that has been brought forward by Dr. Smyth, Mr. Cruick-ſhank, and others. EDIT.

There

There are many more inductions of facts which unite in the eſtabliſhment of the general principle Dr. Mitchill has inveſtigated. Some of theſe have been publiſhed in America, and ſome exiſt ſtill in manuſcript. The deſire of writing a book ſeems never to have influenced him. Accordingly he has generally conducted his diſcuſſions in the form of letters to his friends and correſpondents: and even theſe he has never collected into a volume; they lie ſcattered about in magazines and diſſertations where they were firſt inſerted. There is a promiſe, however, of printing the whole in the Medical Repoſitory, where they may in ſucceſſion be laid before the learned world. In this immenſe inquiry, it is hoped, he will be aſſiſted by the candour and talents of thoſe ſcientific inquirers who are now-a-days making ſuch vaſt diſcoveries in Europe.

V. *Account of a Voyage to Spitſbergen in the Year* 1780. *By* S. BACSTROM, M. D. *Communicated by the Author.*

SIR,

HAVING received much gratification from a peruſal of your Magazine, I ſend you a few particulars reſpecting a voyage which I made to Spitſbergen in the year 1780, extracted from a journal I kept at the time; which you may lay before your readers, if you think they can contribute either to their information or amuſement.

The Editor of the Philoſophical Magazine.

I am, &c.
S. BACSTROM.

A VOYAGE to Greenland, as it is called, though in fact to the iſland of Spitſbergen, for the purpoſe of killing the black whale-fiſh, is one of the healthieſt that can be undertaken, and furniſhes ſo much curious matter for amuſement to perſons of an inquiſitive turn of mind, that even a ſecond will hardly ſatisfy ſuch, if they have been fortunate enough

to

to ſail with a good commander, and in a veſſel well appointed. In both theſe reſpects I was very fortunate, which is rather uncommon; the maſters or commanders in the Greenland trade being generally men of little or no education, and conſequently void of thoſe liberal ſentiments neceſſary to render the ſituation of thoſe who accompany them comfortable. If a regularly educated ſurgeon, from a deſire of viſiting ſuch northern regions, goes in a veſſel under ſuch a perſon as I have deſcribed, he is generally ſickened the firſt voyage; a barber is perhaps his ſucceſſor, and when any illneſs or accident happens on board, if the patient eſcapes with his life, he is often rendered a cripple. I have ſeen ſome inſtances of this kind.

The unſociable diſpoſition of the maſter is not, however, the only circumſtance that often deters from a ſecond voyage. I have known veſſels well ſtored by the owners with every neceſſary and uſeful article, and even a liberal ſupply of what ſome would call luxuries, and yet every comfort withheld from thoſe on board: the maſter literally ſtarving himſelf and officers, and not allowing a bit of fire in the cabin, in theſe cold latitudes, that he might ſave a few coals, ſome dozens of hams and tongues, a quantity of cheeſe, butter, flour, wine, porter, &c. *to ſend home to his own family* at the end of the voyage: a paultry theft, at the expence of the health and froſt-bitten limbs of thoſe on board.

When the reader is informed that ſuch has been my paſſion to viſit foreign climes that I have been no leſs than fifteen voyages, one of them round the world, he will not be ſurpriſed that I ſhould wiſh to gratify my curioſity by viſiting the frozen regions, even though I knew ſomething of the inconveniencies before deſcribed, to which thoſe who undertake the voyage are often expoſed. My buſineſs was to guard againſt them as well as poſſible, by proper inquiries reſpecting the character and diſpoſition of the maſter, and I ſucceeded to my wiſh in two voyages to theſe parts: the firſt was in the Sea Horſe in the year 1779, which yielded me much

much satisfaction; but I was more completely gratified by the second, which is the one I mean to describe.

I engaged myself as surgeon on board the Rising Sun, William Souter master, a well-appointed stout ship of 400 tons burthen, in the employ of Mr. William Ward. The vessel carried about 90 men, and had 20 nine-pounders mounted on the main-deck, with nine whale-boats, some of them hung in the tackles over the sides, and others stowed and lashed on the deck.

We sailed from London in the latter end of March 1780, and, as is usual with Greenlandmen, called at the town of Larwick, the capital of the Shetland isles, where we found a most hospitable reception. A Mr. Innes, the most opulent inhabitant of that country, kept an open table for every master of a vessel and his surgeon; and no language can convey a proper idea of the kind and disinterested manner in which he received and entertained his guests. We lay there fourteen days wind bound. The country has a bleak barren appearance, the surface being generally rocky, or covered with turf, which is the fuel employed there; but the benevolence and hospitality of the more opulent, and the decency, sobriety, and good conduct of all the inhabitants, even those of the lowest class, more than compensate for the barrenness of the soil.

Provisions of every kind, the finer vegetables and fruit excepted, are very abundant here, and extremely reasonable. The price of a good fowl was threepence, of a dozen of new-laid eggs one penny; and as much excellent fish, cod, haddock, halibut, mackerel, &c. could be bought for one shilling, as would cost at least ten pounds at Billingsgate, or as used to dine our whole ship's company and the cabin. Potatoes, turnips, &c. are not more common there than peaches and apricots in England. Wheat flour is also a rare article, but the inhabitants in general prefer bread made of oatmeal.

The town of Larwick consists of about 200 houses, of one, or at most of two stories, which form a narrow crooked lane

on the ſea ſide, badly paved with flat ſtones. All the houſes are built of quarry ſtone: thoſe of the rich are roomy, ſtrong, convenient, and well furniſhed; thoſe of the poor are ſmall, and very ſmoky, for want of a proper arrangement of the chimneys.

Though the place lies in 60° north latitude, the winters are not ſevere; they are, however, wet and ſtormy. The harbour is very capacious and ſafe, and the anchoring ground good. About twenty or more Engliſh Greenlandmen were lying here at anchor, and ſeveral Dutch herring-buſſes. Having filled our empty water-caſks, and laid in a ſtock of fowls, eggs, geneva, &c., we took leave of our kind friends on ſhore, and, the wind being ſoutherly, hove up our anchor and ſet ſail for the ice.

As we advanced to the northward the night became ſhorter till we came near North Cape in lat. 71° 10′, when we had no night at all. We were overtaken in that latitude by a moſt tremendous gale of wind from the north-eaſt, which laſted three days and nights. Our ſhip lay more than once on her beam-ends, and every one on board thought ſhe could never right again; but providentially we weathered the gale. A ſtorm in thoſe high latitudes is ſo intenſely cold, when it blows from the north or north-eaſt, that it is impoſſible to look in the wind's eye, as the cold is ſuch as literally to tear the ſkin off the face.

In about 76° northern latitude we meet with ice floating in ſmall round cakes, by the ſailors called pancakes: you ſail through this ice in perfectly ſmooth water; which, from being of a green colour in the North Sea, Line to the northward of Shetland and Ferro, grows gradually of a darker colour, and looks now of a deep black dye. We ſailed ſeveral days through thoſe floating ice-cakes. When in a ſtill higher latitude, an open black-looking water re-appears; and when you reach about 77 or 78′ you paſs through large maſſes of floating ice 20 or 30 fathom thick, and ſome of them five or ſix times bigger than your own veſſel. Great

care is taken to avoid ſtriking againſt thoſe maſſes, which ſometimes are ſo cloſe that there remains only a narrow channel for the ſhip to ſail through. I have ſeen this continue for 24 hours or longer. When this is the caſe, the commander ſtands in the main or fore-top, and ſometimes higher, and calls down to the men at the wheel how to ſteer. This navigation is attended with great danger, as the ice projects under water ſometimes two or three fathoms.

After navigating through thoſe floating maſſes, we ſaw the land of Spitſbergen eaſt from us. It is ſeen at an almoſt incredible diſtance, ſometimes at thirty leagues; a proof of its immenſe height. It generally appears amazingly bright, of the colour of the full moon; while the ſky above it looks white and cold.

In 79° and 80° you are prevented from going further to the northward by a ſolid continent of ice, or a collection of ice-fields, as they are called; ſome of which are many miles in extent. You make the ſhip faſt there with an ice anchor, and look out for whales, having two or three boats on the watch conſtantly.

No ſhip could ever poſſibly navigate through the huge maſſes of ice, which muſt neceſſarily be paſſed before it can reach this high latitude, but for a circumſtance which would on firſt view be little expected—The ſea there is always as perfectly ſmooth as the River Thames: the irregularly diſpoſed maſſes of ice prevent the water from ever acquiring, by the impulſe of the wind, thoſe regular undulations, if I may uſe the term, which, by long continuance of the ſame impulſe, would otherwiſe at laſt raiſe it in billows.

As ſoon as we got into ſmooth water, perhaps forty or fifty leagues from the land, the ſevere climate and intenſe cold we had experienced on the paſſage in a more ſouthern latitude before we made the ice, changed into a much milder one; and when it was fine weather it was quite warm, ſo that the icicles that hung from the large maſſes of

ice

ice diſſolved and kept dropping till a return of colder weather. Among the fields of ice, but more ſo in the harbours, it is conſiderably warmer than on the paſſage near North Cape.

In the month of June we killed ſeven large whale fiſh, and went with them into Magdalena Bay, to cut the blubber up into ſmall bits to fill the blubber-butts; which buſineſs is called *making off*. As the killing of the whales has been very well deſcribed by Zorgdrager and others, I need not deſcribe it.

When you approach a harbour on the coaſt of Spitſbergen, and, judging by the eye, expect to get in and come to anchor in three or four hours time, you are perhaps not leſs than ten or twelve leagues from it. This deception is owing to the immenſe heights of the rocky mountains, covered with ſnow, and bordered with ice towards the ſea-ſide, which make very large harbours appear like ſmall baſons, and the largeſt ſhips, when cloſe under them, like a boat on the Thames. Magdalena Bay, in 79° north, is capacious enough to hold the whole Britiſh navy; but, on account of the immenſe mountains which ſurround it, appears like a very ſmall inlet. We came to anchor in this bay, where we lay three weeks. While the people were making off, the maſters, ſurgeons, &c. of the different veſſels then there viſited each other, and diverted themſelves in the beſt way they were able. Such viſits laſt ſometimes 24 hours, for there is no night to interrupt the entertainment.

The firſt thing that ſtrikes a curious mind here is that ſolemn ſilence which reigns around; ſometimes interrupted with a noiſe, like thunder heard at a diſtance, occaſioned by huge fragments of ice and rocks rolling down from the immenſe ſteeps into the ſea.

I attempted to aſcend one of theſe mountains called Roche Hill. I got up about half way, which took ſeveral hours hard labour. At that height I found the rocks covered with birds eggs of different ſizes.

There

There are ſeveral rivulets and waterfalls of excellent water ſupplied by the melting of the ſnow. I met frequently with ſcurvy-graſs, wild celery, endive, water-creſſes, and a few other plants and flowers; though the general vegetation which covers the rocks conſiſts in various kinds of moſſes and ferns. There are white bears of an enormous ſize, white foxes, deer, and elks; and above twenty different ſorts of water and land birds; ſuch as, wild geeſe, wild ducks, ſea-parrots, roches, ſea-gulls, mallemooks as the ſailors call them, whoſe quills make the beſt drawing pens I ever met with, wild pigeons, the white duck with a beautiful ſcarlet head and yellow legs, and the ſnow-bird, whoſe note is as pleaſing as that of the bullfinch or nightingale.

This ſeaſon was the fineſt ever remembered in thoſe high latitudes, and we had almoſt conſtant fine weather. As we had room yet on board, and the ſeaſon was not too far advanced, in hopes of killing a fiſh or two more, we left Magdalena Bay and ſteered north. When we arrived in 80° we found a perfectly clear ocean free from ice, but ſaw no whales.

We continued puſhing to the northward with fine ſoutherly breezes and moſt beautiful weather, and could, with a good teleſcope, diſcover no ice to the northward, from the main-top-maſt head, but a ſolid continent of ice eaſt and weſt; ſo that we were in a kind of channel of perhaps three or four leagues wide. We kept puſhing on, the captain and I joking together about paſſing through the pole.

Both Captain Souter and myſelf found ourſelves at length ſome minutes north of 82°, where perhaps no man before us had ever been, nor ſince. The high ſnowy mountains of North Bank, or North Foreland, appeared very luminous, and bore ſouth on the compaſs.

We had a ſtrong inclination to puſh ſtill further north; but the danger of the eaſt and weſt ice, now to the ſouthward of us as well as to the northward, moving and locking us in, in which caſe we muſt have been beſet and inevitably

loſt, created a prudent fear, and induced the maſter to put about ſhip for North Foreland. The wind ſhifted at the ſame time to the northward, and in a couple of days we came to anchor on North Bank, called Smeerenburg's Harbour. We ſaw now plenty of fin-fiſh or finners, white whales, and unicorns; which is a ſign that the ſeaſon is over for killing the black whale, which then retires to the northward. As all theſe animals are well known and deſcribed, I forbear ſaying any thing reſpecting them.

One of our men having been at the habitation of the Ruſſians in North Bank the year before, and aſſuring us that he could find the way to their hut, Captain Souter, a man of an inquiſitive mind, propoſed to me to pay them a viſit. We took ten or twelve men with us, a compaſs, a few bottles of wine, bread, cheeſe, &c., and ſome good trade-knives, with a ſmall keg of gunpowder, to make a preſent of to the Ruſſians.

We landed at the bottom of the harbour to the eaſtward, where we found a large valley, ſeveral miles in breadth, ſurrounded with immenſe high mountains, moſtly covered with ſnow; but as the ſun had melted a part, the brown and black rock appeared, and rivulets of clear water ran down, forming little waterfalls.

The ground was turf and clay, and not bad to walk on: we had ſeveral ſmall rivulets to croſs, of two or three feet wide, but very ſhallow; near them we found ſcurvy-graſs, water-creſſes, endive, wild celery, and a few ſmall flowers, and ſaw a number of land birds flying up at our approach. We croſſed a piece of ground where the Dutch had formerly buried their dead: three or four of the coffins were open, with human ſkeletons lying in them. Some inſcriptions on boards, of which above twenty were erected over the graves, had the years 1630, 1640, &c. affixed to them. We alſo ſaw the ruins of ſome brickwork, which had been a furnace, as the Dutch uſed to boil their oil here in the laſt century, and for that reaſon called it Smeerenburg's Haven, or

the Harbour of the Fat Borough. We had above ſix miles to walk to the northward, and were very much fatigued on account of the unevenneſs of the ground and the heat, when we diſcovered the hut of the Ruſſians at a diſtance. They perceived our approach, and ſent two or three people to meet and welcome us.

The common men made a ſtrange appearance; they looked very much like ſome Jews in Rag Fair or Roſemary-Lane: they wore long beards, fur caps on their heads, brown ſheep-ſkin jackets with the wool outſide, boots, and long knives at their ſides by way of hangers. When we arrived at the hut, we were preſented to the caravelſk or commander, and to the ſurgeon, who both received us very politely, and invited us into the houſe, where we ſat down to reſt and refreſh ourſelves. Our people were introduced to their people in an outer room, and were entertained with meat and brandy. It happened fortunately that the ſurgeon was a German, a native of Berlin, of the name of Iderich Pochenthal, conſequently I could converſe with him; and we both acted as interpreters between his and our commander.

Captain Souter began with offering to the Ruſſian commander, (who was alſo dreſſed in furs, only of a finer ſort, and wore his beard and whiſkers like the common men,) the keg of gunpowder and half a dozen of good table knives and forks: the Ruſſian captain accepted them with a great deal of joy, and made us a preſent in return, conſiſting of half a dozen of white fox ſkins, two brown loaves of rye bread, ſix ſmoked rein-deer tongues, and two rib-pieces of ſmoked deer, for which we kindly thanked him. They turned out to be moſt excellent eating, and of a finer flavour than any Engliſh ſmoked tongues, or hung beef.

We placed our wine on the table, our bread and cheeſe, and the Ruſſian captain ordered boiled ſmoked rein-deer tongues, new rye bread, and good brandy and water to be brought in. We all made a hearty, ſociable meal; the tongues, and the rye bread, which was new and ſavory, were

a rarity to us; the Ruſſian officers reliſhed our Cheſhire cheeſe and ſhip's biſcuit as a very high treat. We drank the Empreſs of Ruſſia's and King George's health. The Ruſſian commander was an elderly man, of very agreeable manners; the ſurgeon extremely ſo, and very intelligent.

The hut conſiſted of two large rooms, each about 30 feet ſquare, but ſo low that I touched the ceiling with my fur cap. In the middle of the front-room was a circular erection of brick-work, which ſerved as an oven to bake their bread, and bake or boil their meat, and at the ſame time performed the office of a ſtove to warm the room. The fuel employed was wood, which drives on ſhore plentifully in whole trees ſtripped of their branches. A chimney carried the ſmoke out of the roof of the hut; but when they wiſhed it, they could, by means of a flue, convey the ſmoke into the back room for the purpoſe of ſmoking and curing their reindeer fleſh and tongues, bears hams, &c. Round three ſides of the front room was raiſed an elevated place of about three feet wide, covered with white bear ſkins, which ſerved for bedſteads. The captain's bed-clothes were made of white fox ſkins ſewed together; the ſurgeon's was the ſame: the boatſwain, cook, carpenter, and the men, had ſheep-ſkins. The walls inſide the room were very ſmooth and white-waſhed; and the ceiling was made of ſtout deal-boards, plained ſmooth, and white-waſhed.

The rooms had a ſufficient number of ſmall glaſs windows, of about two feet ſquare, to afford light: the floor was hard clay, perfectly ſmooth: the whole hut was nearly 60 feet in length, and 34 wide outſide; and was conſtructed of heavy beams cut ſquare, of about twelve inches thick, laid horizontally one upon the other, joined at the four corners by a kind of dove-tailing, caulked with dry moſs, and payed over with tar and pitch, ſo that not a breath of air can penetrate: the roof conſiſted of thin ribs laid acroſs the beam-walls, and three-inch deal nailed over them, ſo that you could walk on the top of the houſe: the roof was caulked and tarred,

tarred, and perfectly tight. This is the manner of building houses in the country in Russia, particularly about Archangel.

The surgeon gave me the following account of this Russian colony in Smeerenburg's Harbour:

Some associated merchants at Archangel fit out a crabbla, or vessel, every year, of about 100 tons, with a commander, mate, surgeon, boatswain, carpenter, cook, and about fifteen hands, well provided with muskets, powder and shot, good large knives, and all kinds of utensils for killing whales, unicorns, rein-deer, bears, and foxes.

With a sufficient stock of rye-flour, brandy, clothing, snow shoes, deal boards, carpenters tools, &c. this vessel sails every year in the month of May from Archangel, goes round the North Cape of Norway, and arrives in June or July at Smeerenburg's Harbour, where the new colony is left on shore. The vessel stays two or three weeks in the harbour to refit, and carries the old colony with their cargo (consisting of whales' blubber, blades or so called whalebone, white bear skins, white fox skins, eiderdown and feathers, unicorns' trunks, which is an ivory that never turns yellow, and smoked rein-deers' tongues,) home to Archangel. The colonists have no wages, but receive thousandth shares for what they bring home: the captain has fifty shares, the mate and surgeon thirty each; the carpenter, boatswain, and cook, ten each; and each common man or boy has one share. The surgeon told me that the captain had above 1000 rubles due to him, and he himself about 600, and each common man perhaps 50 or 60: that when they returned safe home, the common men would be able to live a whole year upon their money, and the officers much longer, as the necessaries of life were very cheap at Archangel; and for the Company it had hitherto answered extremely well.

He told me this was his second trip, so well had it answered his expectations. "During the so called long nights," said he, "it seldom or never is so dark that you cannot see before you, nor is it so dreadfully cold as it is at Petersburg

every winter. When a ſnow ſtorm happens, we cannot go out of the houſe; but when it is ſerene, and no wind, it is not too cold to go out and walk many miles. With the moonlight, the uncommon brilliancy of the ſtars in theſe high latitudes, and the reflection of the northern lights, or *aurora borealis*, we have ſo much light that we can ſee to read a book or to write.

"In winter time the black whales come into the harbour and play cloſe within ſhore, where we kill now and then one with harpoons fired out of a ſwivel. We kill white bears, foxes, rein-deer, and birds, as many as we can before the night-ſeaſon, which commences in September, when all the land animals leave us and walk over the ice into Nova Zembla and Siberia: the land birds leave us in the ſame manner. Unicorns we alſo kill in the harbour, for the ſake of their ivory trunks, which are afterwards ſent to Germany and France."

The ſurgeon and I had a race on ſnow ſhoes, which are a kind of ſkates, of about two feet in length, for ſkating over the ſnow and ice. As I was in former years a good ſkater, I could uſe them as well as he did. We ran ſix or ſeven miles with them in an hour without fatiguing ourſelves: they have no irons.

Before we left our Ruſſian hoſt, he informed us, that a few weeks before they had, coming home from a ſhooting party, found an Engliſh captain and nine or ten men overhauling their property in the hut. The captain, finding that his cheſt had been broke open, and that his rubles were diminiſhed conſiderably, reproached the Engliſh commander with the robbery, and a battle enſued. "The Engliſh fired upon us," ſaid the ſurgeon, who acted all along as interpreter, "and killed one of our men on the ſpot. We returned the fire and wounded ſome of his men, and cauſed them to retreat precipitately. When the Engliſh were gone, our captain counted his rubles, and found that there were 600 miſſing." He intended to ſend a ſtatement of the affair to the Ruſſian government.

After

After having ſtaid above twelve hours with the Ruſſians, highly entertained, we invited them to come to ſee us on board and took our leave, returning the ſame way by the compaſs, and arrived ſafe on board, after having been abſent almoſt eighteen hours.

We now prepared for the voyage home; and, after having filled our empty caſks with good water from the ſhore, and made a clear ſhip, we ſet ſail with a fine north-eaſterly breeze in the middle of July 1780. We ſailed again through a great quantity of floating ice, and, our ſhip being a good ſailer, paſſed ſeveral full ſhips bound homewards.

The firſt pleaſing change we experienced was to have ſome night, and to be obliged to light a candle in the cabin. O what a luxury!—When you have no darkneſs for a conſiderable time (during May, June, and July), light becomes tedious at laſt; and the firſt time you ſee a candle burning in the cabin, and a dark night, the pleaſure is indeſcribable. Before we came into this more ſouthern latitude, I uſed to obſerve the ſetting of the ſun, reſting, as it were, on the horizon, appearing of a very large ſize, ſurrounded with moſt beautiful and glorious colours of various tints, and then the riſing of it ſhortly after in full majeſty. Language cannot convey an idea of the ſcene.

We came to anchor at Larwick towards the end of July, and were received in the kindeſt manner by Mr. Innes and all our friends in the place.

After three weeks ſtay we took leave of our Shetland friends, and ſailed in company with a number of full ſhips for England. When we came on the coaſt of Northumberland and Yorkſhire, the breeze and weather being favourable, we were delighted with the ſmell of the hay from the ſhore, and the ſight of the pretty little towns and villages built on the ſea-ſide, and refreſhed with excellent freſh cod and haddock, which the Yorkſhire cobles (a kind of fiſhing boats) bring on board; in return for which they prefer taking a piece of beef or pork to money: they bring ſome-

times eggs, potatoes, &c. We had an uncommonly pleasant voyage home, and constant fine weather, accompanied with northerly breezes.

We arrived about the latter end of August safe in Greenland Dock, after having been out five months.

Captain Souter kept an excellent table in the cabin, and a constant fire in the stove: his study was to make every person on board comfortable. In the fifteen voyages I have been to sea, I have only twice had the good fortune to sail with men of equal worth; Mr. Charles Patterson of the Sea Horse, and Mr. William Alder, now a Lieutenant in the British Navy.

VI. *An Attempt to arrange the Crystals of Oxidated Tin Ore, according to their supposed Structure. By Mr.* William Day, *Leicester Place. Communicated by the Author.*

THE crystallisations of oxidated tin ore are described by Romé de l'Isle, in his Cristallography, to be of the octaedral form and its modifications; the octaedra having isosceles triangular faces, inclined at an angle of 45° to the base of each pyramid; so that the junction of their bases and apices are right angles. In the following arrangement the octaedron is considered as the primitive form, and the modifications as being produced by an accumulation, on its faces, of laminæ composed of similar minute moleculæ, experiencing different laws of decrement on their sides or angles, or on both. These laws of decrement are marked with the signs invented by Hauy, of which an account has been given in the Phil. Mag. Vol. II. p. 398. The greater part of these forms having been very accurately described by De l'Isle, all that is now attempted is an application of Hauy's system to the arrangement of this part of a private cabinet of English minerals; nor would it have been made public but for the repeated solicitations of several friends.

In

In the annexed drawing (ſee plate III.) all the plans, and alſo the figures marked 1 *a*, 1 *b*, and 1 *c*, are geometrical: the others are drawings from models, and in perſpective as they appear to the eye; but all of them placed in the ſame relative ſituation to the nucleus, fig. 1., on which they are ſuppoſed to be formed. Mathematical correctneſs is not attempted, nor is it neceſſary. The priſms are ſhewn with the pyramid on one end only; not on both, as in De l'Iſle's plates.

Fig. 1, a perſpective view of the primitive octaedron of oxidated tin ore. 1 *a*, a front geometrical elevation, with the quantity of the angles marked upon them. 1 *b*, an angular geometrical elevation, alſo with the quantity of the angles marked upon them. 1 *c*, one of the faces of the octaedron, ſubdivided to ſhew the ſuppoſed arrangement of the primitive moleculæ that form one lamina. The dark triangles repreſent the ſpaces they occupy reſpectively, and the difference of ſhading, the progreſs of diminution by a ſubtraction of one range of moleculæ on the edges of the faces, according to the third law of decrement. The ſuperior angle A of this face is 70°, the two inferior angles E, E, 55° each. The letters on the three geometrical figures mark the ſame ſituations on all of them, and are thoſe employed by Hauy to indicate the laws of decrement.

As Hauy's *ſyſtem* has been given in the Firſt Volume of the Philoſophical Magazine, and his *ſigns* in the Second, little more is required here but to give the ſign to which the figures belong.

Firſt Law of Decrement $\overset{1}{D}_{1}$.

To this law belong fig. 2, 3, and 4. Fig. 2 *a*, without the dotted lines, would repreſent a plan of fig. 2. That portion of fig. 2 *a*, included between the dotted lines *b b*, *b b*, repreſents a plan of fig. 3. The plan of fig. 4 is evident from the figure.

Second Law of Decrement $^{1}E^{1}$.

Fig. 5 belongs to this law: fig. 2 *a*, the angles being taken off at the dotted lines, repreſents a plan of it. Fig. 6 is a

combination of this law with another not yet determined, making the prism sixteen-sided: fig. 6 *a* is the plan.

Third Law of Decrement $B^{1}\,\overset{3}{\underset{1}{D}}\,{}^{1}B$.

Fig. 7 shews it incomplete. The plan is shewn, fig. 22 *a*, including the dotted lines. Fig. 8, the completion of this law: 8 *a* is the plan. Fig. 22 is an irregular formation, by this law taking place unequally: 22 *a*, (without the portion expressed by the dotted lines,) is the plan. The plans of two other unequal accumulations, which disguise the pyramid, are shewn fig. 7 *a*, 7 *b*. Fig. 21, the same as fig. 8, become cuneiform: 21 *a*, the plan.

Fourth Law of Decrement $\overset{1}{A}$.

Fig. 9 shews the combination with the first law: fig. 10, the same with the third law, incomplete: fig. 11, the last completed: fig. 12, the combination with the first and second laws: this, and the combination with the first law only, are in general peculiar to Bohemian and Saxon ores; the English ores exhibit but few examples of them. I have an English crystal similar to fig. 9, and it is the only one I have seen. Fig. 13, the combination with the second and third law: fig. 13 *a* is the plan.

Fifth Law of Decrement $^{2}E^{2}\,\overset{1}{\underset{1}{D}}$.

Fig. 14, the first indication of this law, in combination with the third law, incomplete. Fig. 15, this law farther extended in the same combination: 15 *a*, the plan. Fig. 16, a further extension, but still incomplete: fig. 16 *a*, the plan. Fig. 17, the completion of this decrement: fig. 17 *a*, the plan. Fig. 18, the combination of this law, when arrived at the stage shewn in fig. 16, with the third law. Compare fig. 15 and 18. Fig. 19 and 20 are the same as fig. 16, with some irregularity in the formation.

These five laws of decrement embrace all the varieties of facets I have yet observed (except those mentioned when speaking of fig. 6); and by combination, in different stages of

of each reſpectively, produce a great variety of forms, while other varieties ariſe from difference in colour and tranſparency to which all theſe cryſtalliſations are ſubject.

The macles of De l'Iſle, which Hauy has called *hemitrope*, or half-turned, may be added as a ſupplementary claſs. Of the term *macle*, De l'Iſle gives this explanation: "When in any cryſtal whatever one or more re-entering or internal angles are obſerved, we may conclude that it is not a ſimple cryſtal, but a group of two or more; or even two turned or reverſed moieties of the ſame cryſtal." De l'Iſle was indebted to a Mr. Lermina for determining the direction of the ſection which produced the hemitrope cryſtals of tin, which he has ſhewn to be parallel to two oppoſite edges of the octaedron. Imagine the primitive octaedron to be divided into halves by a plane paſſing diagonally through it, from the centre B, fig. 24, of one of the edges of the ſuperior pyramid, to the centre B of that edge of the inferior pyramid which is diagonally oppoſite; the plane will paſs through two oppoſite angles FE of the baſe, dividing on each pyramid two adjoining faces into four ſcalene triangles, and leaving two adjoining faces perfect, but reverſed on one pyramid in reſpect to the other. The plane FBEB' of this ſection is a rhomb of 60° and 120°.

The priſmatic cryſtals appear to be as ſuſceptible of that ſpecies of accumulation which produces the hemitrope as the octaedron, and the ſection is always parallel to the one determined above. If the priſm is ſhort, and terminated by two pyramids, the ſection will paſs through the priſm into both pyramids, and be irregularly octagon; but if the priſm is long enough to permit the ſection to paſs through it without encroaching on the pyramids, it will be a rhomb of 70° and 110°; the ſame as the ſection of the primitive octaedron, perpendicular from the apex, and diagonally acroſs the baſe.

I have ſome cryſtals which are produced by a double ſection, and both ends turned on the middle part; others which appear to be only portions taken off the angles at the junc-

tions

tions of the pyramids to the prism, and reversed together without the intermediate part. In fact, the varieties appear to be almost innumerable.

After I had made the above arrangement, I received the 32d Number of the *Journal des Mines*, from which I beg leave to subjoin the following extracts:

"The primitive form of the crystals of oxydated tin appeared to me to be that of a cube performing the function of a parallelopipedon; so that the decrements which produce the secondary forms have, in regard to the two opposite faces of the cube, which must be considered as the bases, an action different from that which takes place in regard to the other four faces that represent the planes of the prism." (p. 576.)

"One of the rarest varieties of this kind is that represented fig. 7 *, and which is the seventh of Romé de Lisle, T. III. p. 422. We give it the name of *disliquè* oxyd of tin; that is to say, with two ranges of facets. It has altogether thirty-six faces; four of which M M are vertical, and on each side eight inferior oblique z, z, and eight superior oblique o, s. If, as usual, we denote the edges of the base of the cubic nucleus by B, and the angles by A, we shall have, as the indicating sign of this variety, $M\ (\overset{1}{\overset{\cdot}{A}}\,B^2\,B^s)\ \overset{1}{B}\,\overset{2}{A}$, in which the intermediary decrement is referred to the facets z, z', the decrement $\overset{1}{B}$ to the facets $s.s$, and the decrement $\overset{2}{A}$ to the facets o, o. The following is the indication of the principal angles: incidence of M to M 90°, of z to z 116° 20′, of z to z' 158° 30′, of s to s 120°, of o to s 150°. Quantity of the angle n 118° 4′." (*Suite de l'Extrait du Traité de Mineralogie de* C. Hauy, p. 578.)

From the preceding extracts it appears that Hauy has supposed the cube to be the nucleus or primitive form of the oxidated tin crystals. I have again carefully examined the crystals in my own collection, and, according to the indi-

* Fig. 23 is a tracing from Hauy's fig. 7, referred to here, and is the same crystal as represented fig. 18.

cations

cations obſerved on them, from which I have formed my arrangement agreeably to the law laid down by Hauy himſelf, (ſee Phil. Mag. Vol. I. p. 292.) I ſee no reaſon at preſent why I ſhould alter it. The cryſtals of oxidated tin are in general ſo hard and brittle that I have not been able to ſeparate the laminæ; and there is nothing to guide the obſerver but the direction of the ſtriæ on the ſecondary facets. Now the faces, which are parallel to the faces of the octaedron before mentioned, are always very brilliant; but thoſe which are on a plane with the edges are ſtriated parallel to thoſe edges, particularly thoſe cryſtals which ſhew the intermediate ſtages of the third law. If the nucleus were a cube, and the laminæ accumulated on it, to form the ſecondary cryſtals, ſhewed their direction by ſtriæ on the new facets, thoſe ſtriæ would be in a direction quite contrary to what are ſhewn on theſe cryſtals: inſtead of going the length of the new facets parallel to the edges of the octaedron, they would croſs the facets perpendicularly to their preſent direction, and it would be impoſſible for the cryſtal fig. 7 to take the form of fig. 8. In my collection there is a group of opaque black cryſtals, ſhewing all the variations from the primitive priſmatic cryſtal fig. 2, to the completion of the third law of decrement fig. 8. In all of them the direction of the ſtriæ is very evident. The Saxon and Bohemian ores of tin are moſt common in the cabinets of France: the cryſtals are larger, but do not preſent the varieties of forms that Engliſh ores do; being moſtly confined to the octaedron and its hemitrope, and thoſe variations of the fourth law which approach the cube. Had Hauy ſeen a greater number of the varieties of the Engliſh tin ores, I think he would, for the primitive form, have had recourſe to the octaedron, which, by a very ſimple law of decrement, produces the cube and its varieties that occur in the tin cryſtalliſations.

To theſe obſervations may be added De l'Iſle's deſcription of the ſame cryſtal that Hauy has deſcribed (above), which I find

I find to agree so well with what I have observed in nature, that I am inclined to suppose Hauy's measures of the angles are given from calculation, assuming the cube as the nucleus, and not from measurement on the crystal. De l'Isle's description is as follows:

"It is a blackish kind of tin ore, in small solitary crystals five or six lines in length, and at most three in breadth. In the variety in question, one of the extremities of the rectangular tetraedral prism first presents an octaedral pyramid, the planes of which forming with the prism an angle of 155° are irregular pentagons, having one of their angles of 60°, two of 120°, one of 110°, and the most obtuse of 130°. These pentagons form with each other angles of 110° and 160°. The pyramidal form thence resulting is itself terminated by a tetraedral summit with trapezoidal planes joining at right angles, as is observed in the isosceles triangles of the third variety: but this summit becomes octaedral by the slight truncature of its edges, from which result four linear hexagons that form by their contact at the summit of the pyramid obtuse angles of 110°. The planes of the prism, had it not been broken, would be regular hexagons, and the whole crystal would then have thirty-six facets." *De l'Isle's Crystallographie*, Tom. III. p. 423.

Having said so much respecting the external form, a few remarks concerning the chemical analysis of tin ores cannot be misplaced in a paper like the present. On this part of the subject, I cannot do better than by quoting from a paper of C. Guyton, formerly and better known here by the name of De Morveau, whose chemical authority always carries great weight with it. In his paper entitled, *Observations on the Acid of Tin, and an Analysis of its Ores*, after giving the analyses of the brown tin ore of Schlackenwald, as published by Mr. Klaproth, which he verified himself, and found to contain, tin 75, iron 0·5, silex 0·75, and oxygen 23·75 = 100; he proceeds to give a reason why the tin crys-

tals

tals are ſo inſoluble in acids, and combats the idea of Klaproth, that it ariſes from ſuperſaturation by oxygen, which is diſſipated by fluxing the ore with vegetable alkali.

"I believed I had good reaſon," ſays he, "to doubt that the complete oxygenation, or (if the term be preferred) the ſuperſaturation by oxygen, was the true cauſe of its inſolubility in the muriatic acid; becauſe I could not, at any one inſtant of the operation, perceive either the ſubſtance that ſhould take it away, or any of the phenomena that would have accompanied its diſengagement. That I might with the greater facility obſerve all the circumſtances, I operated with a ſmall platina crucible over an Argand's lamp. Fifty-five centigrammes of brown cryſtals of tin were reduced to a fine powder, and mixed with ſix times as much pot-aſh (purified by alcohol, and dried): the mixture was moiſtened with a few drops of water. I evaporated it firſt to dryneſs, and then to a commencement of fuſion. After the firſt treatment, hot water poured on the maſs diſſolved more than half the mineral, which was then firſt precipitated from it by muriatic acid, and afterwards rediſſolved by it with the greateſt facility; and the precipitate of the metallic oxyde, reproduced by adding carbonat of pot-aſh, was found, as ſtated by Klaproth, completely ſoluble again by the ſame acid. After having myſelf witneſſed this fact, my firſt doubt on the direct cauſe of the inſolubility of this ore was rather ſtrengthened than removed. It cannot be ſaid that the exceſs of oxygen eſcaped during the fuſion with the pot-aſh; for the metal could not form a ſoluble combination with alkali, unleſs it was oxidated in the higheſt degree; or, more properly, in the ſtate of an acid, ſo as that the ſolution filtered from the reſidue ſhould be a true ſtannate, or (if the term be preferred) ſtannite of tin *.

"Now, if we are obliged to admit that *all the oxygen* of the ore is again found in the alkaline ſolution, it cannot be the loſs of *a part* of that principle that renders the metal

* The author muſt have written Stannite of pot-aſh. D.

more

more ſoluble in the acid, for it is ſtill found in the ſame ſtate of ſaturation: beſides, it does not exhibit any ſigns of the oxygenated muriatic acid gas; and in this caſe it is difficult to conceive why there ſhould not rather be a diſengagement of this gas at the time of digeſtion of the acid on the ore, as happens with the oxydes of manganeſe and lead.

"To eſtabliſh this point of theory on a deciſive experiment, I diſſolved ſix grammes of tin in nitrous acid, which I evaporated ſeveral times to dryneſs, adding each time freſh acid. I think it cannot be doubted that in this ſtate the tin had taken all the oxygen it was capable of fixing; yet the maſs of white oxyd, waſhed till the water that came from it did not in the leaſt alter vegetable colours, was readily diſſolved in muriatic acid. What then is the cauſe of the inſolubility of the ore, which alſo is nothing but tin and oxygen, containing hardly 0·01 of extraneous matter? The cauſe can only be found in the ſtate of aggregation of the latter. This aſſertion ought not to excite ſurpriſe, for hitherto ſufficient account has not been taken of this power. If combinations are the reſult of affinity or elective attraction, this attraction itſelf is nothing but a power which may be rendered ineffectual by the ſum of the forces which counteract it. Theſe truths ſurely will not be denied by Mr. Klaproth, who has rendered them ſo palpable, by ſhewing us that the ruby, the ſapphire, the adamantine ſpar, the elements of which were naturally eaſily ſoluble, reſiſted the ordinary means of analyſis only by the ſtate of the aggregation of their integral parts."

De l'Iſle, whoſe ſecond edition was publiſhed in 1783, conjectured what Guyton here advances from experiment. His words are as follow:—"I cannot agree with Mr. Bergman, that there is no mineralizing ſubſtance in the cryſtals of tin, becauſe, in default of ſulphur or arſenic, we ought at leaſt to find *the acid principle*, by the aid of which the metallic earth of tin takes a conſtant and determinate cryſtalline form."

VII. *On*

VII. *Experiments reſpecting the Effects of Quickſilver on Vegetable Life.* *By* VON DEIMANN, PAATS VAN TROSTWYK and LAUWERENBURGH *.

EXPER. I. A plant of the ſmall garden bean, which had grown in the open fields, was placed in water cloſe to a flaſk filled with quickſilver one inch in diameter, and the water was covered by a bell twelve inches in height and ſix in diameter.

II. A plant of curled mint, the root of which ſtood in water, was placed with quickſilver under a bell eight inches in height and four and a half in diameter.

III. The firſt experiment was repeated, with this variation; that the bell, inſtead of ſtanding over water, was placed on a diſh, and ſupported by pieces of cork.

IV. The ſame experiment as the ſecond, with this difference; that pieces of leaf gold were ſuſpended in the bell.

V. A flaſk filled with quickſilver was placed cloſe to ſome young plants of the *ſpiræa ſalicifolia*, which ſtill adhered to the parent root, and the whole was covered with a bell.

VI. The ſecond experiment was repeated, and a little ſulphur was applied to the interior ſides of the bell.

VII. The ſecond experiment again repeated, with this difference; that the quickſilver was covered with a little water.

VIII. A plant of the curled mint was placed in a baſon of water with a little quickſilver, in ſuch a manner that the roots were in contact with the metal.

IX. The roots of a bean plant, which had ſhot out through holes made in the pot in which it had been reared, were placed in a flat diſh filled with quickſilver.

X. Some beans were planted in earth mixed with quickſilver.

XI. A plant of the curled mint was placed in a baſon with water, and red oxyd of mercury prepared with the

* From Scherer's *Allgemeines Journal der Chemie*, Vol. I. No. 6.

nitrous acid which had been waſhed firſt with an alcaline ſolution and then with pure water, the roots being immerſed in the oxyd.

XII. The ſame as the ſecond, with this variation; that inſtead of quickſilver the oxyd was uſed.

XIII. Beans were planted in a mixture of earth and the red oxyd of quickſilver.

XIV. The ſame planted in earth mixed with the oxyd of lead.

XV. Of three plants of the curled mint, one was placed, in the ſame manner as in the 11th experiment, in a phial which contained water and the oxyd of manganeſe; the ſecond in another, containing water and the oxyd of copper; and the third in one containing water and the oxyd of lead.

The leaves and ſtems in the experiments 1, 2, 3, 4, and 5, were on the third day covered with black ſpots; and on the fourth, fifth, and at moſt the ſixth, had become entirely black. The young tree in the 5th experiment could not hold out the whole ſummer, though it ſtood connected with the parent plant. The plants died ſo completely that the leaves frequently dropped off, and the ſtem ſunk down the very moment the bell was removed. The plants in the 6th experiment remained without any change, which ſhews that ſulphur prevents the bad effects of the quickſilver. In the 7th experiment the effect of the quickſilver was deſtroyed, on account of the water by which it was covered.

The experiments 8, 9, and 10, prove that the quickſilver, when mixed with earth or water, or when it ſtands in contact with the roots of plants, is in no manner prejudicial to them.

The 11th experiment, which we repeated ſeveral times, ſhewed us that the oxyd of quickſilver, placed in contact with the roots of a plant, is deſtructive to it. This oxyd, however, did not produce the ſame effect when it was placed as the metallic quickſilver, near to the plant; as was proved by the 12th experiment, in which the plant did not experience the leaſt change.

In

In the 15th experiment the plants were not in the leaſt affected by the different oxyds; which proves that plants, like animals, ſeem capable of being accuſtomed to things pernicious to them, provided they begin at infancy. The beans planted in earth mixed with the oxyd of quickſilver grew up, but ſo weak and ſtunted that they could ſcarcely be known. Thoſe, however, which had been planted at the ſame time as the former in a mixture of earth and the oxyd of lead, ſhot up as uſual, and exceeded them in ſtrength and weight more than four times.

In theſe reſearches we were at great pains to make ſome comparative experiments, and we found that the plants in thoſe where no quickſilver was employed, lived a conſiderable time in a ſtate of perfect vegetation. Theſe reſults we give merely as facts, without attempting at preſent to explain them. A conſiderable quantity of quickſilver placed in a very confined atmoſphere may be equally pernicious to animal exiſtence, as we think ourſelves authoriſed to infer from ſeveral experiments, the courſe of which the late ſeaſon of the year obliged us to ſuſpend, and from which it appears that, in one point of view, things hurtful to animals are hurtful alſo to plants.

VIII. *Obſervations on Animal Electricity*; *being the Subſtance of two Letters from* A. VOLTA *to* Profeſſor GREN.

[Concluded from Page 68.]

THE very conſiderable difference in regard to the quantity of effect in the before-mentioned experiments already ſhews, that if the electric ſtream excited by contact is ſtrongeſt towards a certain metal, when that metal is placed between a certain fluid on the one ſide, and another fluid on the other, there are other fluids which produce a greater effect with another kind of metal; ſo that it will be neceſſary to diſcover by experiment the particular arrangement of

conductors suited to each metal, in which the fluids or conductors of the second class must be disposed according to their activity. I have paid great attention to this circumstance, and have formed several tables, which I shall publish as soon as I have brought them to perfection.

I shall here, however, only observe, that in order to class, in some manner, the innumerable different moist conductors of this kind, I distinguish them into aqueous, spiritous, mucous, and gelatinous, saccharine, saponaceous, saline, acid, alcaline, and sulphurous (livers of sulphur) liquids; that I make subdivisions in the acids down to the best known simple mineral acids, (as I find in this respect great difference between the nitrous and the muriatic acids,) comprehending the principal vegetable acids and the acid of galls; and do the same in regard to the saline fluids, according as they are solutions of neutral salts, earthy salts, and particularly metallic salts.

When it can be determined in what order all these kinds of fluids follow each other, in regard to the power in question, for the metal A, and another for the metal B, &c., we shall then be in a condition to determine what place must be assigned to a great number of other heterogeneous fluids, whether mineral, vegetable, or animal, which belong to several of the above classes. In general, the order for the greater part of the metals hitherto observed is as follows: 1st, pure water; 2d, water mixed with clay or chalk, (which shews a pretty different effect when the before-mentioned experiment is made with two glasses, a bow of tin or zinc, and a properly prepared frog, which has a sufficient degree of vitality); 3d, a solution of sugar; 4th, alcohol; 5th, milk; 6th, mucilaginous fluids; 7th, animal gelatinous fluids; 8th, wine; 9th, vinegar, and other vegetable juices and acids; 10th, saliva; 11th, mucus of the nose; 12th, blood; 13th, brains; 14th, solution of salt; 15th, soap suds; 16th, chalk water; 17th, concentrated mineral acids; 18th, strong alcaline leys; 19th, alcaline fluids; 20th, livers of sulphur.

With

With ſome metals there is, however, a conſiderable deviation from this order, in regard to livers of ſulphur, alcaline fluids, and the nitrous and ſaline acids.

As to the metals, which in their poſition between theſe different fluids are more or leſs proper for the electric effect in queſtion, I have found in general that tin exceeds all others, and that ſilver is the worſt; except when one of the fluids betwixt which the ſilver is placed is water, or any other aqueous conductor, and the other liver of ſulphur: in this caſe ſilver far exceeds zinc, and even tin. Iron alſo produces a much greater effect than any other metal, when it is in contact, on the one ſide, with mere water or an aqueous conductor, and on the other with the nitrous acid, were it even only a drop. The excitement occaſioned in both caſes is wonderful; ſince it exceeds, as I have already remarked, that produced, according to the uſual method, by means of a double metallic bow, even of different metals, as zinc and ſilver, applied to conductors of the ſecond claſs of the ſame kind. It is ſufficiently ſtrong and powerful to produce convulſive movement in a half-prepared frog, the bowels of which have not been taken out, when one of the two moiſt conductors is a concentrated alcaline ſolution, and the metal placed between them is zinc, or rather tin. With other metals and other fluids you can ſeldom produce convulſions in a frog, if it be not perfectly prepared, or at leaſt embowelled.

The reader will readily perceive, that when a bow of one and the ſame metal touches with both its ends the ſame kind of ſaline water, the ſame acid, the ſame alcaline fluid, &c. an electric ſtream will not take place, as happens alſo when it touches on each ſide merely water: in that caſe two oppoſite actions are oppoſed to each other, and keep each other in equilibrium. That theſe contrary powers, however, may be in perfect equilibrium, it is neceſſary that the fluids applied to both ends of the homogeneous metalline bow be exactly of the ſame kind and of the ſame ſtrength. For this reaſon the

moſt careful attention and a certain dexterity are required in order to enſure ſucceſs to the experiment, which I have often performed to the great aſtoniſhment of the ſpectators, and which any one may repeat as was done by my friend Humboldt. That philoſopher has already publiſhed ſome of the moſt ſtriking and deciſive of theſe experiments in his ſecond letter; and I ſhall here give a more particular account of them.

Having placed a completely or only half-prepared frog as uſual in two glaſſes of water, take a very clean bow of ſilver (it will be beſt when it has been waſhed with water from the glaſſes), and immerſe both ends of it at once, or the one after the other, in the glaſſes, no agitation of the frog will be occaſioned. Repeat the experiment, after you have daubed over one end of the bow with the white of an egg, liquid glue, ſaliva, mucus, blood, a ſolution of tartar, or any other fluid or conducting ſubſtance ſufficiently different from pure water. Firſt, immerſe the pure end, or that moiſtened merely with water, in the water of one of the glaſſes; and afterwards the other end, daubed over with the above ſubſtances, in the water of the other glaſs; you will then infallibly produce a convulſive movement in the frog, and ſeveral times in ſucceſſion, if you draw out the bow and again immerſe it until nothing more of the above ſubſtances is left adhering to the metal, or until the metal, with its ends in both the glaſſes, touches only pure, or nearly pure, water. Daub both the above ſubſtances uniformly over both ends of the bow, and immerſe them at the ſame time in both the glaſſes of water, and no convulſions will ariſe. They will often be produced in newly prepared and highly irritable frogs, when the ſaline fluid, or, in general, the ſubſtance with which the two ends of the bow are daubed over, is not perfectly the ſame, or when the ſubſtance at the one end is more diluted than at the other, &c. Waſh and clean carefully the one end of the bow, daub over the other more or leſs, and convulſions will be again produced as ſoon as the circle is made complete by the

the double immerſion of the bow. Clean both ends completely, and no agitation will ariſe, as in the firſt experiment.

For comparative experiments of this kind I would recommend viſcous fluids or ſubſtances rather than ſaline, becauſe the latter are too ſoon diſſolved in the water. It oftimes happens that the convulſions of the frog, when it is completely prepared and highly irritable, take place, though both ends of the metallic bow are daubed over with the ſame kind of ſaline fluid. The cauſe of this is, that when one end is immerſed in the water after the other, (and it may be eaſily ſeen that it is impoſſible to do ſo in a moment with ſufficient accuracy,) the one end of the bow loſes a portion of its ſaline ſubſtance ſooner than the other, or at leaſt the adhering part is more diluted by the water, ſo that the fluid with which both ends have been daubed over is no longer the ſame.

For theſe experiments I would alſo recommend ſilver, as a metal which is leſs liable than others to be attacked and changed by ſaline and other liquids. Tin, lead, copper, and in particular iron, are more ſuſceptible of laſting variations; ſo that bows of theſe metals, and of iron above all, retain for a long time the power of producing convulſions in a newly prepared and highly irritable frog, even when both the ends of the bow are immerſed in two glaſſes of water, although the places of the metal, attacked by any of the ſaline fluids, have been carefully waſhed and cleaned. A ſuperficial alteration in the metal is ſufficient to produce this change, as may be eaſily ſeen. Theſe variations often ſhew themſelves to the eye by a yellow blackiſh ſpot, &c. which it is difficult to remove. I do not here ſpeak of laſting variations, that proceed to a greater depth, which can be produced in the end of the metallic bow, and particularly in iron, when its hardneſs is changed; a proceſs by which ſuch a bow can be rendered capable of producing not only convulſions in frogs, but alſo a particular ſenſation on the tongue, and light before the eyes, if both its ends, made perfectly clean, are only brought into contact with pure water. Theſe, and many

other experiments of the like kind, form the chief ſubject of my firſt letter to the Abbé Vaſſali, Profeſſor of Natural Philoſophy at Turin, written in the beginning of the year 1794, and afterwards publiſhed with the other in Brugnatelli's Journal.

If ſilver be leſs expoſed to be attacked by ſaline and other fluids (except by liver of ſulphur, which inſtantaneouſly renders it black); if it be leſs ſuſceptible of conſiderable and laſting variations, and has therefore this advantage over other metals, that it is liable to fewer irregularities; tin, on account of its greater activity, that is, the ſtrength of the effects which it produces by being brought into contact with almoſt all moiſt conductors, as I have already obſerved, is to be preferred to ſilver, and in a certain degree to all other metals. The experiment I have already deſcribed with a tin baſon filled with an alcaline fluid, and held in the hands moiſtened with water, by which an acid ſenſation is excited on the tongue when brought into contact with the above fluid, is a proof of it; for it would be vain to expect a like effect from a baſon of lead, iron, or copper, and much more ſo from one of ſilver. With the latter it would be obtained only when it contained liquid liver of ſulphur; and in that caſe the acid taſte would be pretty ſtrong.

The electric fluid is excited alſo with the greateſt ſtrength and activity, when the metal is tin, between water and a ſaline fluid: but it will be excited with ſtill greater energy to produce an acid ſenſation on the tongue when the tin is between water and an inſipid mucilaginous fluid; or when the experiment is made with a tin baſon filled with a ſolution of gum, liquid glue, white of an egg, &c. The other metals, in like circumſtances, produce ſome effect, but much weaker: ſilver produces the weakeſt, except with liver of ſulphur, as I have already obſerved.

A like experiment, which I made three years ago, and exhibited to various perſons, not with two different fluids and one metal, as in that above deſcribed, but contrariwiſe,

with two metals of a different kind and a fluid, is already known. I took a bafon of tin (one of zinc is better), placed it on a filver ftand, and filled it with water. When any of the perfons in company applied the tip of his tongue to the water, he found it perfectly taftelefs as long as he did not touch the filver ftand; but as foon as he laid hold of the ftand, and grafped it in his hands well moiftened, he experienced on the tongue a very perceptible and pretty ftrong acid tafte. This experiment will fucceed, though the effect is proportionably weaker, with a chain of feveral perfons who hold each other's hands, after they have been moiftened with water, while the firft applies the tip of his tongue to the water in the bafon, and the laft lays hold with his hands of the filver ftand.

If thefe experiments, in regard to the tafte excited on the tongue by the action of two different metals, are ftriking, the others, in regard to the tafte excited, modified and changed by one metal between two different fluids, are no lefs fo, and they are alfo newer. They are ftill intereffing on this account, that they difcover to us the caufe of that tafte often perceived in water and other liquids, which is more or lefs confiderable or various when drunk from veffels of metal, and particularly of tin. When the outer extremity of the veffel is applied to the under lip, rendered moift by the faliva, and the tongue is extended fo as to be in contact with the water, beer, wine, &c. in the veffel, or when the tongue is bent as is done in drinking, is there not then a complete circle, and is not the metal between two more or lefs different liquids, that is, between the faliva of the under lip and the liquor in the cup or veffel? A ftronger or weaker electric ftream muft thereby be occafioned according as the fluids are different—a ftream which will not fail in its way to affect the fenfible organs of the tongue in the faid circle.

Befides the two methods already confidered, of producing an electric current, that is, by means of one or more moift conductors, or conductors of the fecond clafs, placed between two different metals or conductors of the firft clafs;

or

or contrariwiſe by means of a conductor of the firſt claſs placed between two of the ſecond claſs, alſo different; there is ſtill a third method of exciting the electric fluid, though in a degree ſo much weaker that it is ſcarcely capable of cauſing convulſions in a perfectly prepared frog, in which there is ſtill a ſtrong degree of vitality. This new method conſiſts in forming the circle of three different conductors, all of the ſecond claſs, without the intervention of one of the firſt or a metal one. Some think they find in this method a ſtrong objection againſt my principle.

Fig. 20. repreſents this third method compared with the other two*. In the experiments of Profeſſor Valli, reſpecting which ſo much noiſe has been made without any reaſon, *t* repreſents the leg of the frog, and particularly the hard tendinous part of the *Muſculus gaſtrocnemius*; *m* the rump or the muſcles of the back, or the iſchiatic nerves, to which the ſaid tendinous parts are applied; and *a* the blood, or the viſcous ſaponaceous or ſaline fluid, applied to the point of contact.

I have fully deſcribed this new method, where no metal is uſed, in my third and fourth letter to Profeſſor Vaſſali, written in the autumn and winter of the year 1795. I have there ſhewn, that theſe new facts, far from altering my ideas and principles, ſerve rather to eſtabliſh them; and that they render more general the principle that the conductors, by heterogeneous contact, that is of two different from each other, become exciters of electricity, and confirm the beautiful law ariſing from it, that to produce an electric ſtream the circle muſt neceſſarily be formed of three different conductors. You now ſee in what the whole ſecret, the whole magic conſiſts; and that it depends not merely on metals, as might have been believed, but on all the different conductors. As long as we adhere to theſe principles, it will be eaſy to explain all the before-mentioned experiments without being reduced to the neceſſity of having recourſe to any imaginary

* See Plate I. (in the preceding Number.)

principle,

principle, or any peculiar and active electricity of the organs. By their aſſiſtance you will be enabled to invent new experiments, and to foretell the reſult of them, as I have ſeveral times done, and ſtill do daily. If you, however, abandon theſe principles, you will find nothing but uncertainty and contradiction, and the whole will be an inexplicable problem.

IX. *On the Method of manufacturing Acetat of Copper, Cryſtals of Venus, or Cryſtalliſed Verdigriſe. By* J. A. Chaptal.*

CRYSTALS of Venus were for a long time manufactured in Holland, but at preſent they are manufactured at Montpellier, with a degree of perfection which renders them preferable to thoſe of any other country. The proceſs moſt generally employed conſiſts in diſſolving verdigriſe in vinegar, and evaporating the ſolution to a pellicle to obtain the cryſtals. The vinegar uſed is nothing elſe than ſour *vinaſſe* (ſpoilt wine) diſtilled. In every manufactory there is therefore an alembic, in which this weak kind of vinegar is continually diſtilled.

This diſtilled vinegar is put into a kettle, where it is boiled on the verdigriſe. After ſaturation the ſolution is left to clarify, and then poured into another kettle of copper, where it is evaporated to a pellicle. Sticks are then immerſed into it, and by means of ſome pack-thread are tied to wooden bars which reſt on the edge of the kettle. Theſe ſticks are about a foot long, and are ſplit croſs-wiſe nearly two inches at the end, ſo that they open into four branches, kept at about the diſtance of an inch from each other by ſmall pegs. The cryſtals adhere to theſe ſticks, and cover them entirely, forming themſelves into groups or cluſters, which preſent on all ſides perfect rhombs of a very lively dark blue colour.

* From the *Annales de Chimie*, No. 75.

Each

Each cluſter weighs from five to ſix pounds. Theſe cryſtals, when broken, exhibit on their fracture a brilliant agreeable green, inclining a little to blue.

Three pounds of moiſt verdigriſe are neceſſary to make a pound of cryſtals. The indiſſolved reſiduum is rejected as uſeleſs. Analyſis, however, having proved to me that a great deal of copper in a metallic ſtate, or weakly oxydated, ſtill exiſts in it, I diſpoſed boards in the form of a ſtage around the manufactory of C. Durand, and, forming ſtrata of about two inches in thickneſs with theſe remains, I ſoon ſaw them covered with an efflorescence of verdigriſe. I took care to moiſten them from time to time with vinegar, to diſſolve the verdigriſe as ſoon as a ſufficiently ſtrong efflorescence was formed, and they were again diſpoſed in ſtrata to proceed as before, in order that I might derive as much advantage from the reſiduum as I ſhould find convenient.

There are ſome manufactories of the cryſtals of Venus where the verdigriſe is prepared by means of vinegar diſtilled according to the method followed at Grenoble, which is well underſtood. All the operations tend to the ſame end, which is the ſolution of the copper in the acetous acid; and the purity of the materials renders it certain that there will be no reſiduum or loſs. But however ſimple may be the proceſs for manufacturing cryſtalliſed verdigriſe, the high price at which it is ſold makes it to be much wiſhed that it could be ſtill rendered more ſo. I made ſome experiments for that purpoſe; but at preſent I ſhall confine myſelf to a ſhort view of my reſults. We muſt ſet out from the principle, that the acetous acid does not attack copper in the ſtate of a metal, and that it cannot effect a ſolution of it but when reduced to an oxyd. The queſtion then will be to diſcover the means of oxydating it in an economical manner.

1ſt, I expoſed the plates of copper to the gazeous emanations of the oxygenated muriatic acid in large glaſs receivers, connected together in the manner of adoptors, to which I fitted a retort from which the acid was diſengaged.

2d, I took

2d, I took a large earthen jar of Provence, well glazed, capable of containing two hundred (French) pints of water, buried it one half in a ſtratum of very warm dung in full decompoſition, and having put ſome manganeſe in the bottom of it, and adapted to it a ſtraight glaſs tube which reached from the mouth to the bottom, I filled the jar with plates of copper ſlightly rolled, in order that they might not touch each other but in ſome points. I then made to paſs into the bottom of the jar, by means of the tube, the neceſſary quantity of the muriatic acid, and immediately cloſed the upper aperture with a luted covering. Two days after theſe plates were entirely cruſted over with a greeniſh oxyd, which detached itſelf in duſt and in ſcales: I ſeparated of it two pounds ten ounces. This oxyd, leſs lively than that of the common verdigriſe, is ſoluble in vinegar: and this method may then be employed, with ſome advantage, to form the acetat of copper; but it cannot ſupply the place of the acetous verdigriſe either in painting or dyeing.

3d, I formed ſulphat of copper by pouring, upon plates of copper brought to a red heat in a crucible, about a third in weight of pounded ſulphur. This ſulphure, exceedingly friable, pulveriſed and expoſed to a pretty violent heat for four or five hours, left a grey powder, eaſily attacked by the acetous acid. That which I digeſted at a heat above a gentle temperature, gave, by evaporation, a conſiderable quantity of very blue and beautiful cryſtals of acetat of copper, and a ſtratum of true ſulphat of copper of a pale blue and without cryſtals.

4th, I ſaturated diſtilled acetous acid with oxygenated muriatic acid gas. This acid, digeſted cold on the copper, diſſolved it in part; but it formed a beautiful micaceous ſcaly white, which had no relation with the acetat. Copper expoſed to the vapour of this acetous acid, ſaturated with oxygenated muriatic acid gas, becomes covered with very brilliant ſmall cryſtals of a bright-blue colour, ſome of which are tranſparent and white. Theſe cryſtals preſented long

ſquare

ſquare pyramids, efflorefced in the air, and had none of the characters of the acetat of copper.

5th, The acetous acid, diſtilled ſeveral times on the oxyd of manganeſe, attacks copper and diſſolves it, but too weakly and in too ſmall quantity for me to recommend this method.

6th, The acetite of lead poured upon a ſolution of the ſulphat of copper immediately produces a decompoſition from which there reſults ſulphat of lead, which precipitates itſelf in a little time; and acetat of copper, which remains in ſolution. By decanting the latter, and evaporating it to a pellicle in a copper kettle, you will obtain beautiful cryſtals of Venus. If you waſh well the ſulphat of lead, and prepare it to be employed in painting, as white lead, this laſt proceſs may become very advantageous.

Cryſtalliſed verdigriſe is in great requeſt for painting and varniſhing, to which it ſupplies lively and durable colours. Chemiſts obtain from it by diſtillation that acid, the ſmell of which is very penetrating, called *radical vinegar* and alſo *acetic acid*.

X. *An Attempt to determine the true Form and neceſſary Angles of Weather that ought to be given to Vanes of a Vertical Windmill as they recede from the Centre, left undetermined by Mr. Smeaton. By* RICHARD HALL GOWER, *in the Sea Service of the Honourable Eaſt India Company* *.

ON reading Mr. Smeaton's Experiments to diſcover the proper Conſtruction of Windmill Vanes, read before the Royal Society the 31ſt of May and the 14th of June 1759, I was ſorry to find that millwrights had hitherto been without any fixed principle wherewith to give the vanes of vertical windmills their proper degree of weather.

If it were required to determine by calculation the number

* Communicated by the Author.

of

of turns that would be made in a given time by a ventilator in a window, the fly of a ſmoke-jack, or the vanes of a vertical windmill, with a given velocity of wind, we muſt conſider each vane as a ſpiral curve; for ſuch a vane, when ſtruck by a reſiſting fluid, muſt of neceſſity paſs through a triangular ſpace, of which the ſpread of the extremity of the vane forms the baſe, in the time that the wind paſſes through the depth of the vane: therefore, friction and gravity being out of the queſtion, a fly of one vane will paſs round as quick as a fly with any greater number.

Some years back I made a number of experiments upon ſpiral flies moving in water, to prove what number of turns the ſpiral would *actually* make in paſſing through a certain ſpace in the direction of its axis; and I can with confidence aſſert, that (if the ſpiral be nicely made, and be ſuch as ſhall be generated by a radius moving angular, and at the ſame time perpendicular to the plane of its angular motion *) the revolutions it will make in paſſing through a certain ſpace of water in the direction of its axis, *will admit of calculation*; but that, if the flies deviate from a ſpiral, the revolutions *are not to be calculated with exactneſs*, being ever *leſs* than the perfect ſpiral will perform. Wind is a fluid in ſome reſpects ſimilar to water, particularly when applied to the preſent purpoſe; therefore, vanes which are to be turned by its power, *ought to be ſpirals, for, if not, they will ever perform leſs*.

For the purpoſe of elucidating, in the moſt clear and ſimple manner, the truth of the principle aſſerted, I cauſed a vane, or fly, to be made. This vane is repreſented by fig. 1, pl. IV. The vane moves round upon the pillar AB, which is fixed upright in a ſtand. The part of the pillar above the fly is ſquare; this carries the braſs arm CG, which may be moved up and down the pillar, parallel to itſelf, without revolving.

* This conſtruction might be otherwiſe expreſſed, thus: A ſpiral generated by the circular motion of a radius, and of a line moving at right angles, to the plane of the circular motion.

To this arm is fixed the ſtraight wires 1, 2, 3, 4, 5, 6, 7, which are intended to repreſent the wind, moving parallel, to ſtrike the vanes. To prove the truth of the principle, lift the arm up (as in fig. 1,) till the points of the wires are as high as the upper edge of the vanes, and bring the upper edge of either vane immediately under the points; then, by gently preſſing the arm down, (as ſhewn by fig. 2,) it will be obſerved that the vane is turned by *all* the points preſſing upon it *at the ſame time*, till they paſs beyond its lower edge. Now, were the vanes any other than ſpirals, this could not be the caſe; for, bring the wires to the *plane vane* AH (fig. 3), (which may be ſet to any angle), and by preſſing the arm down as before, it will be obſerved that, as the vane turns round, the points, beginning from the extremity, are quitted by the vane, which at length is acted upon by the point next the centre only: therefore it may be concluded, that the wind would not continue to act *uniformly* on any fly or vane which is not conſtructed on the principles of a ſpiral.

The ſpiral vane I, fig. 1, ends, as do the reſt, where the angle of weather (or the angle which the vane makes with the plane of its circular motion) arrives at 35°, as this admits of the extremity of the vane being ſtruck by the wind with an angle of 54°; which angle, it is demonſtrated, will produce the greateſt lateral preſſure. The ſhortening of the vanes of windmills is an object of material moment; yet I do not mean to aſſert that the angle of 35 degrees is the beſt concluding point, ſince, if more power be wanted, the length of the vanes muſt be extended. The wood, of which I formed my model, is preſerved at the back of the vanes, (ſee the dotted lines fig. 1.) merely to give a better idea of their weather as they recede from the centre. Though the number of ſpiral vanes ſhewn are ſix, yet I do not ſay that ſix are ſuperior to any other number; it being preſumed that more vanes on this principle might be placed with advantage, provided the whole area of the circle be not too much crowded, which would prevent the free eſcape of the wind.

The

The length, breadth, and angle of weather at the extremity of a vane being given; to determine the angles of weather at different diſtances from the centre.

Let AB, fig. 4, be the length of the vane; BC its breadth; and BCD the angle of weather at the extremity of the vane, equal to 20 degrees. With the length of the vane AB, and breadth BC, conſtruct the iſoſceles triangle ABC: from the point B draw BD perpendicular to CB, then BD is the proper depth of the vane.

Divide the line AB into any number of parts (five, for inſtance); at thoſe diviſions draw the lines 1E, 2F, 3G, and 4H, parallel to the line BC; alſo, from the points of diviſion 1, 2, 3, and 4, draw the lines 1I, 2K, 3L, and 4M, perpendicular to 1E, 2F, 3G, &c. all of them equal in length to BD. Join EI, FK, GL, and HM: then the angles 1EI, 2FK, 3GL, and 4HM, are the angles of weather at thoſe diviſions of the vane; and if the triangles be conceived to ſtand perpendicular with the plane of the paper, the angles I, K, L, M, and D, becoming the vertical angles, the hypothenuſe of theſe triangles will give a perfect idea of the weathering of the vane as it recedes from the centre.

On the ſuppoſition that ſuch a vane were infinitely extended, let us conſider which part of it is moſt applicable to produce power with ſafety. The part of the vane next the centre, till it leſſens the angle of weather to 80 or 70 degrees, ſuſtains but little lateral preſſure; and when the weather arrives at leſs than 20 or 10 degrees, it will ſuſtain no more than at the centre, while, in the former caſe, the preſſure tending to break the vanes is very conſiderable. If we conſult a figure, conſtructed to ſhew the lateral and direct preſſure that would ariſe from fluids ſtriking ſurfaces with different degrees of obliquity, I think it may be concluded, *that the part of the vane between the weather of* 80 *and* 20 *degrees, will produce the greateſt effect with the leaſt danger.*

XI. *On the Aſſaying of Iron Ores and Iron Stones by Fuſion. By Mr.* DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

AMONGST the numerous and varied attainments of human genius, the reſults obtained in the practice of the art of fuſion are not the leaſt to ſtamp the induſtry of man with that full approbation to which the moſt ardent perſeverance has entitled him. Deſtitute of the knowledge of principle, and labouring under the moſt violent prejudices, the artiſt has in all ages marked, at lengthened intervals, the coincidence of cauſe with effect: upon precedent alone he has ventured to enlarge his operations, and ſtake his fame and fortune. To this chiefly may be attributed his partial ſucceſs; and by this alone can we account for the exiſtence of manufactures, at an early period of civiliſation, in this and in other countries. Although we cannot withhold our applauſe from ſuch unremitting induſtry, yet the deep-rooted prejudices which this implicit reverence for cuſtom has foſtered are much to be regretted. In periods remote from our time, allowance will be readily granted for perſevering in a mode of practice in which others had been comparatively ſucceſsful; now, however, when inveſtigation is abroad, the foundation of theſe principles ought to be tried by experiment, as the only ſtandard whereby we are enabled to aſcertain truth or detect error. At this impartial tribunal, errors may be detected which corrode the vitals of our manufactories; and truths which have hitherto ſlept, mingled in the rubbiſh of unenlightened tradition, be brought to full view.

In our manufactories, the juſt combination of art with ſcience is what we can ſeldom boaſt; in authors the ſame happy union of theory and practice is alſo markedly deficient; and we have conſtantly to regret, that the want of liberality in the individuals of the one claſs, and opportunity in that of the other, prevent us from feeling the happy effects of this ſo much deſired union.

The

The proceſs of depriving ores of their metal by fuſion in the aſſay-furnace, and that part particularly relating to iron, which I mean to make the principal ſubject of this paper, lead me more immediately to make theſe obſervations. With the manufacturer, in general, the uſes and propriety of the aſſay-furnace are ſeldom admitted, or, at beſt, are reſtricted to ſuch narrow limits as to be only capable of aſcertaining the quantity of iron contained in ore or iron-ſtone. The chemiſt, on the other hand, intent only upon effecting his operation, and of giving accuracy to the reſult, confines his obſervations to a certain chain of ſcience, and ſeldom or never conſiders manufactures as the ultimate and happy end towards which his labours ſhould be directed.

With whatever deference and reſpect we look up to the names of men celebrated for their indefatigable zeal and induſtry in the cauſe of ſcience, and with whatever ſatisfaction we reſt upon the reſult of their labours as to truth; yet, in general, the practical man feels diſſatisfied with the manner in which thoſe ſubjects are treated which come more immediately under his own obſervation.

It is I fear with ſome truth that this charge is brought againſt that part of the arts relative to the aſſaying of iron ores. We never find, in the works of thoſe whoſe attention has been directed to this ſubject, that the leaſt connected idea ever exiſts betwixt the aſſay and the blaſt-furnace, or that the agents uſed for reduction in the laboratory can in general be applied to works in the large way. A total ſilence prevails amongſt authors of this claſs, as to the various qualities of crude iron which certain ores and certain combinations of fluxes produce: all ores, however various, are reduced to the ſame complex treatment, and the operation itſelf meaſured by minutes, as if the fuſibility of all the widely differently-combined ores was the ſame.

The celebrated Bergman even, has a degree of complexity in his receipts for the aſſaying of iron ores, that ſeems un-

worthy of the ſimple elements of ſcience. The following one in particular ſeems to poſſeſs an air of incongruity even in the proportions, only equalled by the oddity of the aſſemblage of mixtures brought forward:

" 100 Grains of the roaſted ore, two parts of the black " flux, (equal parts of borax and nitre,) one part of tartar, " one of ſal-ammoniac, one of ſandever, half of (again) " borax, half of glaſs, one-fourth of *clean ſoot*, one-fourth " of charcoal; the whole to be covered with common ſalt."

This motley aſſociation of earths, alkalies, and ſalts, is recommended as the beſt flux for ALL iron ores. The author however ſhews, that the advantages which it poſſeſſes are not complete, from the great caution preſcribed in the mode of conveying the neceſſary degree of heat; and the perfection of the operation is rendered altogether doubtful by the conſequences which the overſight of a *few minutes* may occaſion.

It cannot be well reconciled to our ideas of advancement in any art, that we have not yet diſcovered a method of operation more perfect than that wherein a few minutes loſt or gained (which error will more likely take place from the inequality of heat, than the reckoning of time,) make a variation from truth equal to 1-5th or 1-6th of the whole. The manufacturer would be in a lamentable predicament were he thus circumſtanced, and obliged, by ſome means or other, to take the crude iron from the blaſt-furnace immediately upon being ſeparated from the ores, leſt a conſiderable portion of it ſhould totally diſappear. If the degree of heat produced from a ſmith's forge was at all times the ſame, though ſupplied with fuel of various natures, and under different changes of temperature, then it is moſt probable that, by reckoning Bergman's time to a minute, a button of iron, accurate in its reſults, might be obtained from *ſome* ores by the flux he has directed to be uſed. But I cannot conceive that this ſhould be an univerſal conſequence: far leſs can I comprehend, after a juſt ſeparation has been effected, that

five minutes will deſtroy 1-10th of the produce of metal, while the incumbent fluid protects the ſurface of the metallic button from the action of the atmoſphere.

It is not, however, my province to enter into a minute examination of the products obtained from the uſe of ſuch vitreous fluxes, which are always productive of the moſt oxygenated ſtate of crude iron; and the accuracy of whoſe reſults, under a ſtate of ſuch high oxygenation, are always to be ſuſpected. I have frequently proved that, in uſing them, the affinity of the metal was ſo great to oxygen, that a ſlight derangement of the crucible, which had thrown the vitrid fluid from any point of the ſurface, was immediately attended by a rapid deflagration, and a conſiderable portion of the iron oxydated.

I ſhall chiefly confine myſelf to a communication of thoſe facts, which I have repeatedly confirmed, with a view of extending my reſults and obſervations to a more extenſive ſcale. I have conſtantly conſidered the aſſay-furnace as capable of affording concluſions applicable to the operations of the ſmelting-furnace, and that change or innovation ſhould always have the concurring teſtimony of truth to back them, though, on a ſmall ſcale, before they be riſqued on one more momentous or extenſive. Influenced by ſuch motives, I early rejected, as totally inapplicable to the ſcale of manufacture, the numerous tribe of ſalts, alkalies, and earths: theſe, in the application, are ſubject to no rule, nor guided by any immediate object of general utility, but are as arbitrary as their authors are numerous. On the contrary, I have directed my endeavours to the uſe of ſuch agents as effect ſeparation upon the large ſcale, and have been fortunate to find that the ſame ſolvents, when properly applied, are productive of the moſt perfect and finiſhed reſults. By the ſimple application of lime or chalk, in various proportions, as a calcareous earth, and common bottle glaſs, in the place of ſilex, to conſtitute fuſibility, I have been able to produce in the aſſay-furnace all the various qualities of crude

iron, as to ſtrength and fuſibility. In no caſe has the reſult of any aſſay been conſidered perfect, unleſs the vitrid maſs found upon the ſurface of the metallic button exhibited a degree of tranſparency and purity of colour little inferior to flint glaſs, or ſlightly darkened by a faint ſhade of azure. In ſuch vitrifications, purity of colour is the ſureſt proof of the non-exiſtence of iron in the ſtate of a fuſed oxyd: the ſame degree of pellucidity renders it eaſy to detect the ſmalleſt globule of metal which by chance may have been ſuſpended during fuſion. In all experiments where a juſt aſſociation of mixtures has been preſent to produce this peculiar ſcoria, the quality of the iron will be found richly carbonated, and the button poſſeſſing a ſmooth, ſilvery, greaſy-feel ſurface. On the other hand, experience has repeatedly ſhewn, that when the ſcoria obtained in aſſaying approached not to the colour and purity of fine glaſs, there remained a portion of the iron ſtill unrevived, in the ſtate of a fuſed oxyde, conveying colour and opacity to the maſs; that at certain degrees of colour, certain degrees of opacity exiſted, and proportionate quantities of the metal remained diffuſed in the ſcoria. When the colour of this was green, the quantity of metal united was ſmall; but as the green deepened, and became aſſociated with light browns, the quantity of unrevived iron was greater, and became much increaſed as the ſcoria aſſumed darker browns, or became totally black: in ſuch inſtances I have found it contain, upon being re-aſſayed, 12 *per cent.* The aſſaying of iron ores is ſuſceptible of another extreme, by which experiment is equally clogged, and wherein it is very difficult to obtain an accurate reſult. In this caſe no perfect button of metal is found, but the portion of iron which the ore contained is in a vaſt variety of various ſized globules of the richeſt crude iron, interſperſed in, or covering the ſurface of a ſemi-vitrified opaque maſs of ſcoria, of a greyiſh-blue, mottled, or whitiſh colour. The cauſes of which, and their ſtrict analogy to ſimilar reſults in the blaſt-furnace, ſhall be my chief object to explain.

In

In a former paper I mentioned, that if iron-ſtones were ſmelted without the addition of any other ſubſtance, the product in iron would be proportioned to the quantity of lime contained in the reſpective claſſes. We ſhall ſee from the following experiments how far this is confirmed by means of the aſſay-furnace, and furniſh to ourſelves one important leſſon, How far the various mixtures of ores affect the operation of ſmelting?

1ſt, Into a crucible, with a well-fitted cover, I introduced 875 grains of a pulveriſed ſiliceous iron-ſtone in its raw ſtate, and applied ſuch degree of heat as is uſually given in ſuch operations. In twelve minutes I found that the iron-ſtone was in perfect fuſion, much agitated, and emitting large bubbles of ignited gas of a fiery colour. In forty minutes the crucible was withdrawn; the ſurface of the vitrid fluid ſtill continued to boil, and emit bubbles, though in leſs quantity. In this ſtate I introduced a ſmall rod through the ſcoria, and diſcovered the ſurface of a button of metal. The moment it came into contact with atmoſpheric air, a beautiful combuſtion took place; the metal roſe in a ſpiral form to ſupply the rapid inflammation, and continued till the ſcoria (ſtill in fuſion) cloſed over the ſurface of the button. When cold, I found a perfect formed button of extremely oxygenated crude iron, which weighed 219 grains; a produce equal to 25.1 *per cent.* from the raw iron-ſtone. The ſcoria obtained was of a ſhining black colour, firm and ponderous, and weighed 402 grains; ſo that the loſs in volatile matter was 254 grains, equal to 29 *per cent.*

Although this iron-ſtone was ſiliceous, yet I am convinced the loſs of volatile matter would have been greater, had not nearly one-half of the whole contents of iron remained in the ſcoria, united with oxygen, at the rate of 35 *per cent.* I found the produce of the metallic button thus obtained white as ſilver, and preſenting imperfect radii; the ſurface was conſiderably oxydated, eſpecially where the combuſtion had taken effect.

2d, I ſubjected to a ſimilar treatment 875 grains of an argillaceous iron-ſtone, which contained a uſual proportion of lime; the fuſion of this powder was more difficult than that of the former, though the phenomena exhibited by both during reduction were alike. The crucible was withdrawn from the furnace in forty minutes after introduction, and the ſurface of the button expoſed to combuſtion as before. The deflagration differed little in point of appearance from that effected with the ſiliceous iron-ſtone: the button of crude iron was found oxygenated, and weighed 249 grains; a produce in iron from the raw ſtone = 28.5 *per cent.*: the vitrid maſs was found to weigh 354 grains; the loſs of volatile mixtures was therefore 272 grains, or 31 *per cent.* The fracture of the regulus now obtained was ſtill white, though not allied to any degree of cryſtalliſation, and its ſurface ſmoother and leſs oxydated. The glaſs produced in this experiment was of a deep brown ſhining colour, in many places porous, and enriched with fine tints of colouring.

3d, The ſame experiment was repeated upon 875 grains of a fine calcareous iron-ſtone. The fuſion of this required a violent heat of ſeventeen minutes, during which time the diſengagement of a gaſeous ſubſtance was moſt evident; in other reſpects it exhibited the ſame features, when in fuſion, as the two former: the degree and length of heat conveyed was nearly the ſame; and the reſult obtained was a button of carbo-oxygenated crude iron * weighing 261 grains; a produce

* Although in this experiment a true carbonation is effected by means of the preſence of lime alone, yet experience has never confirmed this in the large way; nor ſhewn, after a juſt proportion of materials was in the furnace, that additional lime alone conferred any additional degree of carbonation. The widely different manner in which the heat is excited, and the ſubſtances which are operated upon expoſed to its action, may account for this want of coincidence of effect. It is the ſame principle that C. Clouet has lately ingeniouſly applied to the fabrication of caſt ſteel from bar iron. To the decompoſition of the carbonic acid alone, I attribute the advantages derived from the uſe of lime in the manufacturing of crude iron.

produce in iron equal to 30 *per cent.* from the raw iron-ſtone; fuſed earths, now reduced to an opaque brown glaſs ſtreaked with white, 294 grains: loſs in volatile mixtures 320 grains, or 36.5 *per cent.*

The metallic button produced in this operation had a ſmooth cryſtalliſed ſurface; and, when in fuſion, combined leſs readily with oxygen offered by the contact of atmoſpheric air, than did the former two. The fracture was light grey, with a regular diſtinct grain; the maſs of fuſed earths were diſpoſed after the manner of a cryſtalliſation, in radii, ſhooting from the circumference of a minute circle to the extremity of one larger.

From theſe experiments it is obvious that reguli of crude iron may be obtained from the different claſſes of iron-ſtones, of a reſpectable produce, without any addition whatever; and that the tendency which theſe have to part with their iron is in the exact ratio of the quantity of lime preſent. The following ſtatement exhibits the difference betwixt the real and partial aſſay of the foregoing iron-ſtones.

The ſiliceous iron-ſtone, properly aſſayed, yielded 34.5 *per cent.*, but by fuſion *per ſe* only 25; leaving in the latter method 9.5 mixed with the ſcoria. Argillaceous ſtone, properly aſſayed, gave 35.6, by fuſion *per ſe* 28.5; leaving 7.1 mixed with the ſcoria. Calcareous iron-ſtone, properly aſſayed, yielded 33.7, by fuſion *per ſe* 30; which left 3.7 mixed with the ſcoria.

One reaſon may be advanced why the iron produced from the calcareous ſtone was ſo much more in proportion than the other two claſſes: both the ſiliceous and argillaceous buttons, when deprived of their ſcoria, decompoſed atmoſpheric air ſo rapidly as to ſuffer a little, in point of real metal, from the combination of oxygen. It was otherwiſe, however, when the ſurface of the calcareous button was expoſed: the affinity of the oxygen to the metal being leſs

iron. I have for the laſt three years made uſe of this truth with the greateſt advantage in the aſſaying of ores and other experiments.

than

than to the carbon united with it, carbonic acid was formed. A review of theſe experiments leads to another concluſion, that, without the preſence of carbon, either in chemical union in the ore, or attracted from the ignited gas by the particles of metal, crude iron will not ſeparate from the ore or ſtone; and that, in proportion as the metal is expoſed to inhale this principle, its produce is increaſed and its quality improved.

It will further appear obvious, from the various natures of ſcoriæ which the different iron-ſtones afford when fuſed *per ſe*, that there exiſts a want of mixture in moſt of them to form, when fuſed, a fluid ſo ſufficiently divided that no portion of iron may be retained, either in a metallic ſtate, or in that of an oxyde. This deficiency of mixture is greateſt in the ſiliceous iron-ſtones, leſs in the argillaceous, and leaſt of all in the calcareous. The principle, therefore, I proceeded upon was, to aſcertain what proportion of additional mixture, and of what nature, was neceſſary to give the proper equilibrium to form a tranſparent ſcoria. When ſilex predominated, it was found that a major proportion of calcareous earth, in the ſolvent or flux, ſupplied the natural deficiency; and that the whole contents in iron were juſtly revived, and fully ſaturated with carbon: when at any time it was wiſhed to revive the metal, contained in ſuch ores, poſſeſſing ſtrength with carbonation, I found that this could be eaſily effected, in all proportions, by the addition of calcareous earth with a mixture of pure clay. In ſhort, in every experiment I have made with ores, the various natures of lime-ſtones, or chalk, with certain proportions of bottle glaſs, have been found capable of reviving the iron contained in all the ores which have come under my knowledge, and of conferring upon their reſpective products every degree of ſtrength and fuſibility*. In order to form an accurate judgment of the tendency

* Although I have frequently had occaſion to mention the combination of clay with iron-ſtone, as the mixture which in fuſion conveyed ſtrength

dency which individual ores have to afford their metal carbonated, poſſeſſing ſtrength, or otherwiſe, a flux of a medium proportion of calcareous earth and glaſs is determined upon; ſuch as, with an iron-ſtone of that genus, would afford ſuper-carbonated crude iron. Let the button of iron ſo obtained be the ſtandard whereby to judge of ſucceeding reſults; and let all the ores belonging to the ſame mine, or uſed at the ſame work, be compared with it: theſe will be found, according to their mixtures, poſſeſſing different degrees of carbonation; ſome of them white in the fracture, and others again as richly carbonated as the ſtandard regulus; their degrees of ſtrength alſo approaching or receding from the ſtandard as they approximate or vary from the nature and proportion of its original mixture.

To complete ſuch an undertaking with accuracy, requires a minute knowledge of the operations of the aſſay-furnace, and the degree of heat from time to time excited: the quantity of ore in ſuch a chain of experiments ſhould be at all times the ſame, and the requiſite heat conveyed and completed at ſimilar ſtages of fuſion and of ſeparation. Strict

ſtrength to the metal, yet I have not ventured a conjecture how far and in what manner the mechanical ſtructure of the metal is altered when additional ſtrength is thus obtained. It will be a difficult matter to decide, whether it is derived from the natural infuſibility of the clay, by preventing ſeparation for a longer time, and new modifying the ſtructure of the particles of metal; or whether the acquired ſtrength is entirely owing to the molecule of the metal becoming more flattened and tenacious by a varied ſtage of cryſtalliſation. Moſt probably it is owing to both cauſes, and that the former is productive of the latter; the one the cauſe, and the other the effect accounted for.

We find, that from ſiliceous iron-ſtone, which is fuſed with the greateſt facility, iron is obtained uncommonly white and brittle; and again, from pure calcareous iron-ſtones, which are ſtill more difficult to reduce than the other two claſſes, we find an oppoſite extreme of brittleneſs, ariſing from an extra combination of carbon, which deſtroys the continuity of the particles to each other. Clay ſtill holds the medium; and its addition alone reſtores a juſt equilibrium, not of ſtrength only, but of fuſibility.

5 accuracy

accuracy of refult, as to the quantity of metal, will not always be obtained; but a very comprehenfive knowledge will be formed of the nature of the earthy mixtures, and the ftrength and fufibility of the metal. Once in the poffeffion of thefe, it will be no difficult matter to fuperadd a portion of earths requifite for perfect reduction. In two fimple experiments, therefore, not only the real quantity of metal contained in the ore is obtained, but its prefumptive ftrength and fufibility developed in a great meafure prior to its application to the purpofes of the blaft-furnace.

In order to facilitate this operation, and to compare the various degrees of heat in which different experiments are effected, I conftructed a pyrometer upon the principle of the expanfion of metal by heat; a repreferitation of which, and a defcription of its ufe, will form an article for the next Number of the Philofophical Magazine.

XII. *Agenda, or a Collection of Obfervations and Refearches the Refults of which may ferve as the Foundation for a Theory of the Earth. By* M. De Saussure.

[Continued from page 71.]

CHAP. XVII.

Obfervations to be made on the Remains and Veftiges of organized Bodies found in the Earth, in Mountains, and at their Surface.

1. THEIR nature, bulk, and quantity; the extent, depth, and other dimenfions of the ftrata where they are found *.

2. Their prefervation. Whether entire or broken, decompofed or not; fhells with their pearly covering (*nacre*); their colour; remains or traces of their fifh, or their fkin if there be any. To deduce, if poffible, from thefe data, fome idea

* 1. A. If formed of trees, to mark down the direction of the ftrata; and whether they are placed horizontally, or inclined either towards the fummit or the roots. C.

of

of the time that has elapſed ſince theſe organiſed beings were depoſited in the boſom or at the ſurface of the earth.

3. The nature of the objects by which they are accompanied; ſuch as ſand, gravel, flints: whether angular or round; whether there are found in their neighbourhood other veſtiges of organiſed bodies *.

4. Their nature. Whether they are lying in their natural poſition, or reverſed, and turned upſide down, ſo as to afford reaſon to conclude that they died on the ſpots which they now occupy; or whether they have been tranſported thither by ſome violent and irregular movement: whether, for example, the ſhells have the ſame attitude as in the boſom of the ſea, the univalves on their mouth, and the bivalves on the valve that is leaſt convex.

5. Whether they are in families, as in ſtagnant waters; or, on the contrary, thrown together in an irregular manner.

6. Whether all theſe circumſtances are the ſame throughout the whole extent of the ſame bank; in the contiguous banks of the ſame lands, and the ſame mountains, and in thoſe of the neighbourhood.

7. To aſcertain whether foſſil ſhells are found in the moſt ancient mountains, and not in thoſe of a more recent formation; and thus to claſs, if poſſible, the relative ages and epochs of the apparition of the different ſpecies.

8. To compare exactly the bones, ſhells, and foſſil plants with the living plants analogous to them; and thus to aſcertain the truth of the aſſertion of Michaelis, that the foſſil bones of quadrupeds (ſuch as the elephant, rhinoceros, oxen, and ſtags,) have not an exact reſemblance to thoſe which are found at preſent alive.

9. If they are really different, to determine whether theſe differences are not varieties, or whether they characteriſe ſpecies.

10. Whether, on the other hand, their identity is con-

* To pay particular attention to thoſe of ſuch organiſed bodies as may be found in the real veins. C.

firmed

firmed with thoſe of analogous living ones; viz. to aſcertain whether theſe analogous living ones are found at preſent, or have been found within the memory of man, in thoſe countries which contain remains of them; and if the anſwer is negative, to diſcover the ſituation and diſtance of the neareſt country where they are found.

11. If no analogous ones exiſt alive at preſent but in climates where the temperature is very different, to aſcertain whether there are any indications of their having formerly exiſted, and of their having been conveyed to thoſe countries where remains of them are ſtill found; or whether, on the contrary, theſe remains ſeem to have been tranſported thither by currents, tides, or any other great movement of the waters.

12. In the like manner, whether there are found in the cold countries veſtiges of the productions of warm countries; or reciprocally, whether in warm countries there are found veſtiges of the productions of cold countries.

13. Whether foſſil wood, or other veſtiges of organiſed bodies, are ſituated in ſuch a manner as to indicate that there were in the ancient ocean iſlands abounding with animals and vegetables.

14. To ſtudy with care the immenſe accumulations of bones depoſited in heaps (*nids*), or ſtrata, in the iſles of Cherſo, Oſero, and elſewhere.

15. To examine the nature of the caverns which contain them; ſuch as *Baumannſhœle*, and others*.

16. Whether it appears that theſe caverns were the voluntary retreats of thoſe animals who died there a natural death, or whether their bodies were conveyed thither by the waters†.

[To be continued.]

* In the Harz, and thoſe of Gailenreuth in Franconia. C.

† Or, whether theſe bones are found, not only in caverns, but alſo in the ſtrata from which the caverns have been formed. C.

XIII. *On*

XIII. *On the Cure of Perſons bitten by Snakes in India**. *By* JOHN WILLIAMS, *Eſq.*

THE following ſtatement of facts relative to the cure of perſons bitten by ſnakes, ſelected from a number of caſes which have come within my own knowledge, require no prefatory introduction, as it points out the means of obtaining the greateſt ſelf-gratification the human mind is capable of experiencing, That of the preſervation of the life of a fellow-creature, and ſnatching him from the jaws of death, by a method which every perſon is capable of availing himſelf of. Eau de Luce, I learn from many communications which I have received from different parts of the country, anſwers as well as the pure cauſtic alkali ſpirit; and though, from its having ſome eſſential oils in its compoſition, it may not be ſo powerful, yet, as it muſt be given with water, it only requires to increaſe the doſe in proportion; and, ſo long as it retains its milky white colour, it is ſufficiently efficacious.

From the effect of a ligature applied between the part bitten and the heart, it is evident that the poiſon diffuſes itſelf over the body by the returning venous blood; deſtroying the irritability, and rendering the ſyſtem paralytic. It is therefore probable that the volatile cauſtic alkali, in reſiſting the diſeaſe of the poiſon, does not act ſo much as a ſpecific in deſtroying its quality, as by counteracting the effect on the ſyſtem, by ſtimulating the fibres, and preſerving that irritability which it tends to deſtroy.

CASE I. In the month of Auguſt 1780, a ſervant of mine was bitten in the heel, as he ſuppoſed, by a ſnake; and in a few minutes was in great agony, with convulſions about the throat and jaws, and continual grinding of the teeth. Having a wiſh to try the effects of volatile alkali in ſuch caſes, I gave him about forty drops of Eau de Luce in water, and applied ſome of it to the part bitten. The doſe was re-

* From the *Aſiatic Reſearches*.

peated

peated every eight or ten minutes, till a ſmall phialful was expended: it was near two hours before it could be ſaid he was out of danger. A numbneſs and pricking ſenſation was perceived extending itſelf up to the knee, where a ligature was applied ſo tight as to ſtop the returning venous blood, which ſeemingly checked the progreſs of the deleterious poiſon. The foot and leg, up to where the ligature was made, were ſtiff and painful for ſeveral days, and, which appeared very ſingular, were covered with a branny ſcale.

The above was the firſt caſe in which I tried the effects of the volatile alkali, and, apprehending that the eſſential oils in the compoſition of Eau de Luce, though made of the ſtrong cauſtic volatile ſpirit, would conſiderably diminiſh its powers, I was induced, the next opportunity that offered, to try the effects of pure volatile cauſtic alkali ſpirit, and accordingly prepared ſome from quicklime and the ſal ammoniac of this country.

II. In July 1782, a woman of the Brahmen caſt, who lived in my neighbourhood at Chunar, was bitten by a Cobra de Capello between the thumb and fore-finger of her right hand. Prayers and ſuperſtitious incantations were practiſed by the Brahmens about her, till ſhe became ſpeechleſs and convulſed, with locked jaws, and a profuſe diſcharge of ſaliva running from her mouth. On being informed of the accident, I immediately ſent a ſervant with a bottle of the volatile cauſtic alkali ſpirit, of which he poured about a tea-ſpoonful, mixed with water, down her throat, and applied ſome of it to the part bitten. The doſe was repeated a few minutes after, when ſhe was evidently better, and in about half an hour was perfectly recovered.

This accident happened in a ſmall hut, where I ſaw the ſnake, which was a middle-ſized Cobra de Capello. The Brahmens would not allow it to be killed. In the above caſe, no other means whatever were uſed for the recovery of the patient than are here recited.

III. A woman-ſervant in the family of a gentleman at Benares,

Benares, was bitten in the foot by a Cobra de Capello. The gentleman immediately applied to me for ſome of the volatile cauſtic alkali, which I fortunately had by me. I gave her about ſixty drops in water, and alſo applied ſome of it to the part bitten. In about ſeven or eight minutes after, ſhe was perfectly recovered. In the above caſe I was not witneſs to the deleterious effect of the poiſon on the patient; but ſaw the ſnake after it was killed.

IV. In July 1784 the wife of a ſervant of mine was bitten by a Cobra de Capello on the outſide of the little toe of her right foot. In a few minutes ſhe became convulſed, particularly about the jaws and throat, with a continued gnaſhing of the teeth. She at firſt complained of a numbneſs extending from the wound upwards; but no ligature was applied to the limb. About ſixty drops of the volatile cauſtic ſpirit were given to her in water, by forcing open her mouth, which was ſtrongly convulſed: in about ſeven minutes the doſe was repeated, when the convulſions left her; and in three more ſhe became ſenſible, and ſpoke to thoſe who attended her. A few drops of the ſpirit had alſo been applied to the wound. The ſnake was killed and brought to me, which proved to be a Cobra de Capello.

V. As it is generally believed that the venom of ſnakes is more malignant during hot dry weather than at any other ſeaſon, the following caſe, which occurred in the month of July 1788, when the weather was extremely hot, no rain excepting a ſlight ſhower having fallen for many months, may not be unworthy of notice:—

A ſervant belonging to an officer at Juanpoor, was bitten by a ſnake on the leg, about two inches above the outer ancle. As the accident happened in the evening, he could not ſee what ſpecies of ſnake it was. He immediately tied a ligature above the part bitten; but was in a few minutes in ſuch exquiſite torture from pain, which extended up his body and to his head, that he ſoon became dizzy and ſenſeleſs. On being informed of the accident, I ſent my ſervant

with a phial of the volatile cauſtic alkali, who found him, when he arrived, quite torpid, with the ſaliva running out of his mouth, and his jaws ſo faſt locked as to render it neceſſary to uſe an inſtrument to open them and adminiſter the medicine. About forty drops of the volatile cauſtic ſpirit were given to him in water, and applied to the wound; and the ſame doſe repeated a few minutes after. In about half an hour he was perfectly recovered. On examining the part bitten, I could diſcover the marks of three fangs; two on one ſide, and one on the other; and, from the diſtance they were aſunder, I ſhould judge it a large ſnake. More than ten minutes did not appear to have elapſed from the time of his being bitten till the medicine was adminiſtered. The wounds healed immediately, and he was able to attend to his duty the next day. Though the ſpecies of ſnake was not aſcertained, yet I judge, from the flow of ſaliva from the mouth, convulſive ſpaſms of the jaws and throat, as well as from the marks of three fangs, that it muſt have been a Cobra de Capello; and though I have met with five and ſix fangs of different ſizes in ſnakes of that ſpecies, I never obſerved the marks of more than two having been applied in biting in any other caſe which came within my knowledge.

VI. In September 1786 a ſervant belonging to Captain S——, who was then at Benares, was bitten in the leg by a large Cobra de Capello. He ſaw the ſnake coming towards him, with his neck ſpread out in a very tremendous manner, and endeavoured to avoid him; but, before he could get out of his way, the ſnake ſeized him by the leg, and ſecured his hold for ſome time, as if he had not been able to extricate his teeth. Application was immediately made to his maſter for a remedy, who ſent to conſult me; but, before I arrived, had given him a quantity of ſweet oil, which he drank. So ſoon as I ſaw him, I directed the uſual doſe of volatile cauſtic alkali to be given, which fortunately brought away the oil from his ſtomach, or it is probable that

that the ſtimulating effect of the volatile ſpirit would have been ſo much blunted by it, as to have become inefficacious: a ſecond doſe was immediately adminiſtered, and ſome time after, a third. The man recovered in the courſe of a few hours. As oil is frequently adminiſtered as a remedy in the bite of ſnakes, I think it neceſſary to caution againſt the uſe of it with the volatile alkali, as it blunts the ſtimulating quality of the ſpirit, and renders it uſeleſs.

Of the numerous ſpecies of ſnakes which I have met with, not above ſix were provided with poiſonous fangs; though I have examined many which have been conſidered by the natives as dangerous, without being able to diſcover any thing noxious in them.

The following is an inſtance of the deleterious effect of the bite of a ſnake, called by the natives Krait, a ſpecies of the Boa, which I have frequently met with in this part of the country:—

VII. On the 16th September 1788 a man was brought to me who had been bitten by a ſnake, with the marks of two fangs on two of his toes; he was ſaid to have been bitten above an hour before I ſaw him: he was perfectly ſenſible, but complained of great pain in the parts bitten, with an unuſual languor. I immediately gave him thirty drops of the volatile cauſtic alkali ſpirit in water, and applied ſome of it to the wounds. In a few minutes he became eaſier, and in about half an hour was carried away by his friends, with perfect confidence in his recovery, without having taken a ſecond doſe of the medicine, which indeed did not appear to have been neceſſary: but whether from the effect of the bite of the ſnake, or the motion of the dooly on which he was carried, I know not; but he became ſick at the ſtomach, threw up the medicine, and died in about a quarter of an hour after. The man ſaid that the ſnake came up to him while he was ſitting on the ground; and that he put him away with his hand once, but that he turned about and bit him, as deſcribed. The ſnake was brought to me, which

I examined: it was about two feet and a half long, of a lightiſh-brown colour on the back, a white belly, and annulated from end to end with 208 abdominal and 46 tail ſcuta. I have met with ſeveral of them from thirteen inches to near three feet in length: it had two poiſonous fangs in the upper jaw, which lay naked, with their points without the upper lip. It does not ſpread its neck, like the Cobra de Capello, when enraged; but is very active and quick in its motion.

I have ſeen inſtances of perſons bitten by ſnakes, who have been ſo long without aſſiſtance that, when they have been brought to me, they have not been able to ſwallow, from convulſions of the throat and fauces, which is, I obſerve, a conſtant ſymptom of the bite of the Cobra de Capello: and indeed I have had many perſons brought to me who had been dead ſome time; but never knew an inſtance of the volatile cauſtic alkali failing in its effect, where the patient has been able to ſwallow it.

XIV. *On the Metallic Particles contained in the Aſhes of Vegetables.* *By* M. De la Metherie *.

FROM obſervations which have been made, there is no reaſon to doubt that Nature never produces any thing new on the one hand, without decompoſing ſomething old on the other. The proceſs of boiling ſaltpetre, explained by the remarks of naturaliſts, has ſhewn that earth, freed from all ſalts by lixiviation, as ſoon as it is heaped up againſt new walls expoſed to the open air, becomes again impregnated with different new ſalts: but theſe, however, have been formed by the experiments of Lavoiſier, Thouvenel, and myſelf, through the effects of various artificial kinds of air. The greater part of ſalts are produced in the ſame manner in organiſed bodies; and thus plants produce vitriolated tartar, ſulphur, nitre, both the fixed alkalies, and perhaps alſo

* From the *Journal de Phyſique*, Vol. XXIII.

volatile

volatile alkali. The animal fluids give fever ſalts, (carbonat of ammonia,) ſal-ammoniac, nitre, &c. Oils both ſweet and eſſential, ſlimy bodies, and extracts belong excluſively to the works of animated Nature. Even the different kinds of gaſes combined with each other produce new kinds, as may be ſeen in plants, which convert foul air into oxygenated. Ought not the other ſubſtances found in organiſed bodies to be aſcribed to the like works of Nature?

Becher and Henkel firſt ſhewed that all vegetables contain iron and gold, and ſince their time this fact has been placed beyond any doubt. Many chemiſts, particularly Lauragais, Rouelle, Darcet, Sage, Berthollet, &c. obtained both theſe metals from plants by reducing them to aſhes *. Are theſe ſubſtances contained in thoſe things which furniſh nouriſhment to plants, or are they produced by vegetation? This queſtion can be applied alſo to the earth contained in plants. Duck-weed and all plants of this kind grow in the pureſt water, and we daily ſee bulbous plants ſhooting up in it.

Van Helmont relates, that he planted a ſhoot of woad, weighing fifty pounds, in a hundred pounds of earth. He watered it with diſtilled water, and in five years it weighed 169 pounds 3 ounces: the earth had loſt of its weight only two ounces. Bonnet and Duhamel reared plants in the pureſt water, and they grew as well as in the beſt ſoil. It may be aſked, then, if particles ſuſceptible of being attracted by the magnet could have been found in the aſhes of theſe plants, as well as in thoſe of plants that grew in fields or gardens?

The author repeated many of theſe experiments. He calcined a part of various ſeeds, and extracted the ferruginous particles from them by means of a magnet; the other part he ſuffered to ſhoot, and to grow up in diſtilled water.

* Since the time of their experiments manganeſe has been found diffuſed through plants, next in quantity to iron. See Scheele's Eſſays. EDIT.

Their ashes gave a much greater quantity of metallic particles than the seeds, and produced also much more earth.

As Nature produces, in plants, salts, oil, and slime, may she not, in like manner, produce earth, iron, and gold in a metallic form? and, in this process, may she not employ water, light, and different kinds of gases, which it appears contribute most to the formation of salts and oils? In this manner metals would be brought very near to saline substances, which several chemists have already suspected.

XV. *Observations on Native Iron found in Strawberries**.

It appears from the preceding article to be a circumstance well known to naturalists, that in the ashes of plants there are a great many particles susceptible of being attracted by the magnet, and which consequently must be of the nature of iron; but that this metal has been found in plants under its original metallic form, is a fact known only to a few. Grains of gold, however, according to the assertion of Becher, have at times been found in grapes, and threads of gold have been discovered in the roots of corn; tin and lead in the interior parts of plants; quicksilver in wood, &c.: but it has never perhaps been thought possible that iron should be found amidst the corroding juices of a plant, because no metal is so easily decomposed as iron, merely by the moisture of the atmosphere, acids, and the like.

A certain anonymous friend of natural history dined with several guests in the month of June 1781, at the house of his sister, situated on the road to Petershof, not far from Petersburgh: after dinner some strawberries were placed on the table, in a plate, as part of the dessert along with other kinds of fruit. The anonymous person ate of the strawberries, as did all the other guests, without perceiving any thing

* From the *Journal de Physique*, Nov. 1783.

remarkable;

remarkable; but one of the company at laſt called his attention to ſome hard black grains which he found in the berries he had eaten, and he ſoon obſerved that grains of the like kind were contained in thoſe which he was eating himſelf. He did not imagine that theſe grains were iron, but he however wrapped them up in a bit of paper and carried them home with him, in order that he might examine them with more attention. He accordingly tried them by a magnet, and having obſerved that they were attracted by it, he entertained no doubt that they were real native iron. It deſerves to be remarked, that the perſon to whom the anonymous naturaliſt was indebted for this diſcovery, and whoſe veracity is free from the leaſt ſuſpicion, aſſerted that he had often before found like particles of iron in the ſtrawberries which he ate on the ſame farm. Theſe particles were of various forms and ſizes, but more or leſs flatted. Their black colour was very ſimilar to that of ore found in dirty iron mines, only that it was much paler.

On cloſer examination, by means of a magnifying glaſs, theſe bodies appeared to be fragments broken off from larger pieces of iron, ſo that, with a little aſſiſtance from the imagination, traces of a regular fracture might be perceived on them. But even, whether we ſuppoſe that they were conveyed into the fruit as bodies before in a ſtate of exiſtence, or were gradually formed in the interior part of them, the explanation of the phenomenon will ſtill be attended with difficulty. Their flatted form ſeems to oppoſe the idea of their having been produced in the fruit; but on the other hand, that of their being conveyed into the fruit with the juices through the ſtem, appears to be attended with much greater difficulty. The moſt ſingular circumſtance is, that ſo many of theſe fruit in that diſtrict ſhould have been furniſhed with theſe ſmall bodies, and that they ſhould have been found exactly in the centre.

Another inſtance of native iron being found, mentioned by the ſame anonymous author, is perhaps leſs ſtriking, but

yet worthy of attention. In the neighbourhood of the town of Baturin in the Ukraine, there are a number of pleaſant little hills interſected by various ravines formed by the waters. In theſe ravines there are found in different places white globular maſſes of calcareous ſtone, which on the outſide bear marks as if they had been rubbed againſt black ſtones; theſe marks do not go deeper than the ſurface, and appear to be the work of ſome mineral pigment. The ſize of theſe maſſes approaches near to that of a walnut: it is however difficult to break them; and the nearer you get to the nucleus, which is diſtinguiſhed from the external covering by a green yellowiſh colour, the finer and harder the grain is found. The middle of this ſtone conſiſts of ſeveral cells ſeparated from each other by partitions, ſome of which are exceedingly thin. Theſe ſtone maſſes may be conſidered either as excreſcences or petrefactions, and may be claſſed among the carpolites or alcyonites; but this is of little conſequence.

What, however, deſerves attention is, that, in one ſpecimen which was broken, there were found in two of the cells two ſmall grains which were immediately known to be iron by their being attracted by a magnet. The ſmaller fell from the hands of the obſerver, and was loſt almoſt as ſoon as it had been diſcovered; but the other, which is ſtill in his poſſeſſion, has the exact ſhape of the cavity in which it lay, and is not much bigger than the head of a large pin. Theſe diſcoveries afford a new proof that the exiſtence of native iron is neither ſo uncommon nor ſo problematical as mankind in general believe.

XVI. *Seventh*

XVI. *Seventh Communication* from Dr.* THORNTON, *Phyſician to the General Diſpenſary, &c. &c. relative to Pneumatic Medicine.*

A REMARKABLE CASE OF PUTRID FEVER CURED BY THE INHALATION OF VITAL AIR.

AFTER attending a family labouring under putrid fever, I was ſeized myſelf with the ſame fever, but it was prevented forming by an emetic and calomel cathartic. It aſſailed next my wife, who being advanced in pregnancy, the ſame remedies could not be applied, and the fever actually formed itſelf. The ſymptoms became ſo alarming, that muſtard cataplaſms were applied to the feet; and there ariſing, towards the cloſe of the diſeaſe, violent ſtartings of the tendons, and a cold clammy ſweat, with a fluttering and ſunk pulſe, I was induced to make trial of the oxygen air nearly in a pure ſtate, and Mrs. Thornton was immediately revived by this remedy, and, after a fever which laſted one and twenty days, recovered. A ſervant in the houſe, and a nurſe, were next ſeized; and I had the maid taken out of bed, and made her inhale thirty quarts of vital air, mixed with twice that quantity of atmoſpheric; which being repeated for a few days, ſhe was completely reſtored. The nurſe had an emetic, and went home. My two children were afterwards ſeized with the ſame fever; and being declared by the gentleman who attended them paſt all hopes, I ordered a carriage to be procured, and took them immediately to the top of Highgate Hill, where they were compoſed to ſleep by the keen country air, and came home greatly revived; which excurſion being repeated daily, they both recovered, to the ſurpriſe of every one. Seeing the good effects of air, and of factitious oxygen air, I adopted both in the fulleſt manner in the inſtance about to be recorded, the reſult of which the reader will ſee from the following

* Theſe are all *original* Communications, never having been before publiſhed. EDITOR.

letter

letter from Mr. Corpe, an eminent ſurgeon and apothecary upwards of thirty years:—

To Dr. Thornton.

Barnet, June 11, 1799.

DEAR SIR,

My daughter was taken, the 27th of February 1798, with chills, followed by ſhiverings, conſiderable loſs of ſtrength, and depreſſion of ſpirits. She continued ſuffering much from chills for about four or five hours, after which ſhe complained of heat and fluſhing in her face, not attended with much thirſt, and was a little delirious that night. The next day the ſymptoms increaſed, and the debility was ſo great that I was obliged, after the firſt paſſages had been thoroughly cleanſed, to have recourſe to wine and bottled porter, together with cordial antiſeptic medicines; which plan was purſued, under your direction, during the progreſs of the diſeaſe; towards the cloſe of which, the poor child was ſo ſhockingly debilitated, that we expected every minute would be her laſt, which induced you to direct vital air*, by which, and the conſtant uſe of ſtrong vinegar, thoroughly ſprayed with a hearth-bruſh all over the room and curtains of the bed, revived her aſtoniſhingly: but the manner in which ſhe conſtantly revived, after inhaling the vital air, muſt be chiefly attributed to it, as the vinegar had been uſed in the way before mentioned almoſt from the very beginning of the diſeaſe, and was, I believe, not only of great uſe to the patient, but prevented the fever ſpreading in my family. No poor human being, I believe, ever had a narrower eſcape from death; and I ſhall always feel myſelf under the higheſt obligations poſſible to you for your attention and extraordinary ſkill in reſtoring my dear child, with God's aſſiſtance, to,

Dear Sir,

Your much obliged and faithful Servant,

JOHN CORPE.

* Sixteen quarts of vital air, mixed with the ſame quantity of atmoſpheric air, were adminiſtered in the evening.

P. S. I had almoſt forgot to obſerve, that the door and windows of my dear child's room were kept almoſt conſtantly open, and, being exactly oppoſite to each other, naturally created a free circulation of freſh air.

Obſervations on this Caſe by Dr. Thornton.

Miſs Corpe, at eighteen when I ſaw her, was convulſed; and the nurſe ſaid, "that, if it was her child, nothing more "ſhould be given;" even her mother requeſted, "if there "really were no hopes, that ſhe might not be diſturbed by "medicine." What increaſed the alarm was: a tradeſman a few doors off had lately died of this ſame fever under this eminent phyſician, leaving behind him a widow and ſix children. The caſe, indeed, ſeemed deplorable; but deſpair ſhould never be allowed while there is life; and it authoriſed the exhibition of the vital air, which undoubtedly contributed much to the recovery of this amiable young lady.

XVII. *On the Glazing of Earthen Veſſels without Lead* *.

AS it is well known that the common glazing by lead employed for earthen ware is of a pernicious nature and prejudicial to the health, H. Nieſeman, a potter at Leipſic, has propoſed the following:—Take nitre, pot-aſh, and common ſalt, of each half a pound, with double that quantity of pulveriſed glaſs, and mix them well together; then take a well baked flat earthen diſh, cover it pretty thick with well beat clay, ſtrew over the clay as much ſand as will adhere to it, and ſuffer it to dry. Put the above ingredients, well mixed, into this diſh, and introduce it into the furnace in order that they may be all fuſed together. The diſh, however, muſt be placed within another, in order that the ingredients may not be loſt in caſe the diſh ſhould happen to crack: but if it be well covered with clay carefully beſtrewed with ſand, little danger is to be apprehended. When the ingredients have

* From *Neue Sammlung œkonomiſcher Schriften.*

been

been fuſed, they are to be pounded very fine in the uſual manner, and may be employed as the common glazing of lead. The colour of this glazing inclines a little to grey, but by the addition of the common calcareous ſpar it acquires a yellow colour: manganeſe gives it a brown colour; and the addition of copper aſhes a green colour. To avoid, however, every thing that has the appearance of being pernicious, this mixture of copper aſhes ſhould be employed only for veſſels which are to be uſed in waſhing. If this glazing is required for any particular purpoſe to be difficult of fuſion, a little leſs litharge may be added to it; but the quantity in all caſes muſt be ſo ſmall as to leave no room for apprehending the leaſt bad conſequences. This ſubſtitute for the common glazing is ſtrongly recommended by Profeſſor Leonhardi.

XVIII. *Geographical Deſcription of the Iſles of France and Bourbon**.

THE Iſle of France was diſcovered in the fifteenth century by the Portugueſe, who called it the Iſle of *Acerno*. The Dutch took poſſeſſion of it in the year 1598, and gave it the name of the Mauritius, in honour of their Stadtholder Prince Maurice. It was not, however, till the year 1640 that they formed a ſettlement there, at a harbour in the ſouth-caſt, which they abandoned in 1712, either on account of the little progreſs it made, or on account of their eſtabliſhment at the Cape of Good Hope. In 1715 the French landed at the harbour in the north-weſt ſide, and named the iſland *Iſle de France*. Soon after, in 1721, the inhabitants of the Iſle of Bourbon, at preſent called *Iſle de la Reunion*, which is ſituated at the diſtance of about ninety miles to the weſt of the Iſle of France, formed a new ſettlement under the direction of Durongay. During fifteen years this colony was in a very languiſhing condition. It was

* From Labarthe's *Annales Maritimes et Coloniales*.

rendered

rendered productive by La Bourdonnaie in 1735; and in 1764 the iſland was given up to the French government by the Eaſt India Company. After that period it was placed under the direction of a governor, and an intendant, or *ordonnateur*.

It lies in 20° 10′ of ſouth latitude and 53° 24′ of eaſt longitude from the meridian of Paris. According to La Caille it is 90,668 toiſes in circumference, 31,890 broad from eaſt to weſt, and contains 432,680 ſquare acres, each of 100 perches, and the perch of 20 feet. It has two harbours; one in the ſouth-eaſt, or the Great Haven, and the other in the north-weſt, called the Small Haven; alſo Port Louis, and, ſince the Revolution, *Port de la Montagne*. The moſt northern harbour is the principal port in the iſland. The north-weſt part of it is perfectly flat, but the ſouth-eaſt is covered with mountains; they are from 300 to 350 toiſes in height: the higheſt, at the mouth of the river Noire, is 424. The moſt remarkable mountain is called Pieterboth; it is 420 toiſes in height, and its ſummit ends in an obeliſk, on which there is a large cubical maſs of rock that no man has yet been able to aſcend.

The iſland is watered by more than ſixty ſtreams, ſome of which, in the droughty ſeaſon, become totally dry, eſpecially ſince the foreſts have been cut down. The interior abounds with lakes, and rain prevails during the greater part of the year, the clouds being attracted by the mountains and foreſts. The ſoil is covered with large or ſmall ſtones; it withſtands the plough, and muſt be cultivated with the hoe, yet it is very proper for various productions. Though of leſs depth and leſs fertility than that of the Iſland of Reunion, it is however, in general, more ſuſceptible of cultivation.

The Iſland of Reunion (Bourbon) was diſcovered alſo by the Portugueſe, who called it Maſcarenhas, after the commander of the fleet; and this name was afterwards corrupted into *Maſcaraigne*. In the year 1642 Pronis, the commandant at Madagaſcar, took poſſeſſion of the iſland for

the French government. Seven years after, this was repeated by the new commandant Deflaccourt, who gave the iſland the name of Bourbon. He introduced into it domeſtic animals, which multiplied conſiderably; and, on account of its fertility, ſeveral Frenchmen formed in it ſettlements. In the year 1665 two ſhips of De la Haie's ſquadron arrived here, and left Renaud, an *officer d'adminiſtration*, together with twenty labourers. The French who in 1671 eſcaped the maſſacre at Fort Dauphin, in Madagaſcar, fled to this iſland; and various ſea-faring perſons ſettled in it, and employed themſelves in agriculture.

It is ſituated about ninety miles from the Iſle of France, to the windward. One day only is ſufficient for going from the Iſle of France to the Iſle of Bourbon, but a month is often neceſſary to return. It is about forty miles in length and thirty in breadth. The ſhores are exceedingly ſteep, and piroguas only can approach them without danger of being overſet. The ſoil is ſandier than that of the Iſle of France: at ſome diſtance from the ſhore it is mixed with thoſe ſmooth ſtones (*galots*) which cover the bottom of the ſea. The ground, however, in thoſe parts which can be cultivated, is excellent. The mountains are exceedingly high: the three inacceſſible peaks, called the *Salaſſes*, are ſaid to be 1600 toiſes. There is here a very awful volcano, the diſtrict around which is entirely burnt up; and alſo a great many gulleys, the declivities of which are ſo ſteep that they cannot be cultivated. The chief port in the iſland is that of St. Denis, where a drawbridge, ſecured by iron chains, has been conſtructed for the purpoſe of enabling boats to land. This bridge extends more than eighty feet into the ſea, and at the end of it is a ladder of ropes by which people who wiſh to go on ſhore muſt aſcend: in all other parts of the iſland they muſt jump into the water.

About fifteen miles to the windward from St. Denis is St. Paul, where the ſea is calmer, and the anchoring ground more ſecure: mariners, however, prefer St. Denis. This

iſland

iſland produces annually 55,700 weight of corn, 54,300 of maize, and three millions of pounds of coffee. The moſt fruitful diſtrict of the iſland is that of St. Suſanne, four leagues from St. Denis.

The ſky is ſerene, the atmoſphere pure, and the water ſalubrious. Land tortoiſes, which were here formerly ſo abundant, are found now only in the weſtern part; in the other parts they have been exterminated by ſhips which have touched at the iſland. The wild goats and wild hogs have retired to the ſummits of the mountains: the rabbits, quails, partridges and pintadoes brought to the iſland have none of them increaſed, except the laſt. Le Gentil mentions as found here a bird called *l'oiſeau bleu*, a very delicate kind of bats; among the vegetable productions, ebony, benjamin, the cotton ſhrub; a great deal of timber for ſhip-building; and among the fruit-trees, the guava, the banana, and orange and lemon trees in great abundance.

NEW PUBLICATIONS.

Commentationes Societatis Regiæ Scientiarum Gottingenſis, &c. Tranſactions of the Royal Society of Gottingen, for the Years 1795—1798. Vol. XIII. quarto. *Gottingen*, 1799.

THE Phyſical Claſs of this volume, to which a preface by Profeſſor Heyne is prefixed, contains the five following treatiſes:——M. Sömmering on an aperture in the centre of the retina of the human eye, obſerved in the body of a perſon who had been drowned.—M. Wriſberg on an unnatural conformation of the organs of generation in a boy.—Profeſſor Gmelin's refutation of the grounds brought againſt the exiſtence of phlogiſton.—Dr. Lentin on the phoſphoric acid as a cure for caries and rottenneſs of the bones.—M. Sömmering on the trunk of the lacteal ducts in the abſorbing veſſels lying on the aorta. The principal papers in the Mathe-

Mathematical Clafs are:——Kaftner on the external furface of the ferew.—Klugel on a new conftruction of a compound object-glafs.—Kaftner on the content of the threads of the ferew and the fpace between. In the Hiftorical and Philological Clafs are:——A paper by Profeffor Heyne, to fhew that there was no extinction and revival of the arts in the middle ages.—Profeffor Heeren on the diverfity and affinity of languages in the ancient kingdom of Perfia.—Gatterer's fourth treatife on the Sarmatian extraction of the Livonians.—Profeffor Heeren on the ancient form of the Perfian gulph.—Profeffor Heyne on the means of difcovering the earlieft ftate of Homer's poems, and of reftoring them.

Memorias da Academia Real das Sciencias de Lifboa, &c. Vol. I. from 1780 to 1788. Lifbon, 1797. Small folio. 575 pages.

THE Academy of Lifbon was indebted for its origin, in the year 1779, to the Duke de la Foes, uncle of the prefent queen, who is alfo prefident of it. The different branches of knowledge to which its attention is directed are: Natural Philofophy, Mathematics, and Domeftic Literature: and the Memoirs are divided into the fame number of claffes.

In the Phyfical Clafs are:—Domenico Vandelli *Floræ et Faunæ Lufitanicæ Specimen*, which is a mere nomenclature: *De Vulcano Olifiponenfi et montis Erminii*, by the fame. The above two papers are in Latin, the reft in Portuguefe. Two papers by Joao Antonio Dalla Bella on the magnetic power. Various obfervations in chemiftry and natural hiftory, by Domingos Vandelli. Obfervations on a plant hygrometer, by Antonio Soarez Barbofa: this hygrometer is made of the twifted beard of the feed of a geranium. Phyfical obfervations in regard to the lightning which in different years had ftruck fome of the royal buildings at Mafra. Meteorological obfervations in various places by different men of learning. On the uncertainty of our knowledge refpecting the plant which produces myrrh, by Joao de Loureiro. On the nature and

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real origin of the *Agallochum*, from a plant entirely new, which the author calls *Aloexylum*, by the ſame.

In the Mathematical Claſs are:——A general ſolution of Kepler's problem *de demetriendo dolio non pleno*, by Joſé Monteiro da Rocha. On the true principles of the doctrine of fluxions, by Borja Garçao Stockler. Additions to the rule of M. Fontaine for ſolving problems reſpecting the quadrature by approximation, by Joſé Monteiro da Rocha. Various obſervations of the eclipſes of Jupiter's ſatellites, made in 1785, in the royal college of Mafra, by D. Joaquim da Aſſumpçao Velho. On determining the longitude and latitude of Liſbon, with the aſtronomical obſervations employed for that purpoſe, by Cuſtodio Gomes de Villas-Boas. Obſervations of the ſame kind, and for the like purpoſe, made at Rio Janeiro, by Bento Sanches Dorta. Aſtronomical obſervations by Franc. Antonio Ciera and Franc. de Oliveira Barboza. Obſervations on the end of the eclipſe of Dec. 17, 1781, made at Carthagena, by D. Jacinto Ceruti. Solution of a problem, propoſed by the Royal Academy of Sciences, reſpecting the approximation of M. Fontaine, by Manoel Joaquim Coelho da Maja.

In the Claſs of Portugueſe Literature a ſeries of papers is announced on the legiſlation and conſtitution of Portugal, by Antonio Caetano do Amaral. The firſt, which is here given, contains an account of the ſtate of Portugal till it became a Roman province. This claſs contains alſo the two following articles:—On the Paſtoral Poetry of the Luſitanians, by Joaquim de Foros; and a hiſtorical elogium of D'Alembert, by Franc. Borja Garçao Stockler.

Philoſophical Tranſactions of the Royal Society of London for the Year 1799. Part I.

The contents are:——I. The Croonian lecture. Experiments and obſervations on the ſtructure of nerves, by Everard Home, Eſq. F. R. S.—II. The Bakerian lecture. Obſervations upon an unuſual horizontal refraction of the air,

with remarks on the variations to which the lower parts of the atmoſphere are ſometimes ſubject; by the Rev. S. Vince, A. M. F. R. S. and Plumian Profeſſor of Aſtronomy and Experimental Philoſophy in the Univerſity of Cambridge.—III. Abſtract of a regiſter of the barometer, thermometer, and rain at Lyndon, in Rutland, 1797; with ſome remarks on the recovery of injured trees: by Thomas Barker, Eſq. Communicated by Mr. Timothy Lane, F. R. S.—IV. Some additions to a paper read in 1790, on the ſubject of a child with a double head: by Everard Home, Eſq. F. R. S.—V. Obſervations on the manners, habits, and natural hiſtory of the Elephant: by John Corſe, Eſq. Communicated by the Right Hon. Sir Joſeph Banks, Bart. K. B. F. R. S.—VI. On the decompoſition of the acid of borax, or ſedative ſalt: by Lawrence de Crell, M. D. F. R. S. London and Edinburgh, and M. R. I. A. Tranſlated from the German.—VI. A method of finding the latitude of a place by means of two altitudes of the ſun, and the time elapſed betwixt the obſervations: by the Rev. W. Lax, A. M. Lowndes's Profeſſor of Aſtronomy in the Univerſity of Cambridge.—VIII. A fourth catalogue of the comparative brightneſs of the ſtars: by William Herſchel, L. L. D. F. R. S.—IX. On a ſub-marine foreſt on the eaſt coaſt of England: by Joſeph Correa de Serra, L. L. D. F. R. S. and A. S.

The Appendix contains a Meteorological Journal, kept at the apartments of the Royal Society by order of the preſident and council.

INTEL-

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

MIDWIFERY.

IN our Second Volume, p. 111, we announced a diſcovery ſaid to have been made by Mr. Herholdt, an eminent accoucheur at Copenhagen, that the apparent death of new-born children aroſe from the trachea being filled with a liquid, and that they might often be reſtored by merely giving them a poſition favourable to its efflux. We then expreſſed a doubt as to the correctneſs of the obſervations; becauſe it appeared impoſſible, from Dr. Goodwyn's experiments, that water could in any caſe enter into the trachea; and becauſe, in thoſe experiments in which it had been forced into the trachea, it had always been abſorbed, if the animal was ſuffered to live. Candour, however, now calls upon us to ſtate, that we find the following article in the Journal de Phyſique for Floreal, an. VII.

"An important diſcovery is announced in the Medico-chirurgical Journal, publiſhed by Profeſſor Tode of Copenhagen *. Herholdt has found, on opening the bodies of ſtill-born animals, that the cavity of the tympanum was filled with the liquor of the amnios and with phlegm (viſcous water). This fluid after birth iſſues by the auditory conduit, and is replaced by atmoſpheric air. This diſcovery induced him to ſuppoſe that the liquor of the amnios is introduced alſo into the canal of reſpiration before the child is born. *Experiments made at the veterinary ſchool have confirmed this hypotheſis.* Nature, in general, diſcharges this liquor, but ſometimes it is neceſſary for that purpoſe to employ the aſſiſtance of art. A child cannot breathe eaſily

* Vol. III. chap. 3. 1798.

until it is freed from it. Herholdt is of opinion, that this accident occaſions more apparent deaths than is commonly believed. It is not ſufficient then to rinſe the child's throat; it muſt be placed in ſuch an attitude as will facilitate the running off of the water. The author has had the good fortune this year to reſtore to life twelve children out of thirteen who were in the like ſituation. Profeſſors Abildgaard and Wiborg have confirmed this experiment by opening five puppies cut from the belly of the mother."

NATURAL HISTORY.

The following incident has lately attracted much notice at Paris:—Citoyen Felix two years ago brought two lions, a male and female, to the national menagerie. About the beginning of June Felix fell ill, and could no longer attend the lions; another was forced to do his duty. The lion, ſad and ſolitary, remained from that moment conſtantly ſeated at the end of his cage, and refuſed to receive any thing from the ſtranger. His preſence even was hateful to him, and he menaced him by bellowing. The company of the female ſeemed alſo to diſpleaſe him; he paid no attention to her. The uneaſineſs of the animal afforded a belief that he was really ill, but no one dared to approach him. At length Felix got well, and meaning to ſurpriſe the lion, he crawled ſoftly to the cage, and ſhewed only his face againſt the bars; the lion in a moment made a bound, leaped againſt the bars, patted him with his paws, licked his hands and face, and trembled with pleaſure. The female ran to him alſo; the lion drove her back, ſeemed angry, and fearful that ſhe ſhould ſnatch any favours from Felix; a quarrel ſeemed about to take place between them, but Felix entered the cage to pacify them. He careſſed them by turns. Felix is now ſeen frequently in the midſt of this formidable couple, whoſe power he has fettered: he holds a kind of converſation with them. Does he wiſh that they ſhould ſeparate and retire each to their cages, he has only to ſpeak a word; does he wiſh that they ſhould lie down to ſhew ſtrangers their paws armed with terrible

terrible claws, and their throats full of tremendous teeth—at the leaſt ſign from him they lie on their backs, hold up their paws one after another, open their throats, and, as a recompence, obtain the favour of licking his hand.—Theſe two animals, of a ſtrong breed, are five years and a half old; they were both of the ſame mother, and have always lived together.

FULMINATING OXYD OF MERCURY.

It is well known that C. Bayen, Brugnatelli, and others, ſome time ago diſcovered that nitrats in general, thoſe of the metals not excepted, detonate with combuſtible ſubſtances, eſpecially with ſulphur. That ſome preparations of gold and of ſilver poſſeſs the property of fulminating without the addition of any inflammable ſubſtance, has alſo been known for ſome time. We have now to announce, that a method of preparing an oxyd of mercury, different from any deſcribed by Bayen or others, that may be fired like gunpowder, and detonates loudly with a gentle ſtroke of a hammer, has juſt been diſcovered by Mr. Edward Howard. We have not yet received a correct account of the proceſs for preparing it, but, from the wonderful expanſive force it exerts on being fired, we have not a doubt that it will prove a very uſeful diſcovery. A few grains of it tried in a gunpowder proof, inſtead of merely raiſing the flap to ſome point within the range of the attached ſcale, fairly ſhot it off; and the piece detached, on being examined, was found to have received ſuch a blow from the newly-generated gas as to be abſolutely dented by it, as if it had received the impreſſion of a punch by means of a heavy hammer: the cavity was exactly the diameter of the bore of the proof, and, what is extremely ſingular, of an equal depth all over. A charge of only thirty-two grains laid open, for two inches in length, the breech-end of a very ſtrong muſket barrel on the two oppoſite ſides, the force being too great to allow time to the gas to wiredraw itſelf (if we may

uſe the term) to enable it to paſs off through the calibre. —In a future Number we ſhall lay farther particulars before our readers reſpecting this diſcovery.

EFFECT OF HYDROGEN GAS ON THE VOICE.

The Journal Britannique, publiſhed at Geneva by Prevoſt, contains the following article:—"Maunoir was one day amuſing himſelf with Paul at Geneva, in breathing pure hydrogen air. He inſpired it with eaſe; and did not perceive that it had any ſenſible effect on him, either in entering his lungs, or paſſing out. But after he had taken in a very large doſe, he was deſirous of ſpeaking, and was aſtoniſhingly ſurpriſed at the ſound of his voice, which was become ſoft, ſhrill, and even ſqueaking, ſo as to alarm him. Paul made the ſame experiment on himſelf, and the ſame effect was produced. I do not know whether any thing ſimilar has occurred in breathing any of the other gaſes."

CHEAP METHOD OF PREVENTING THE DISAGREEABLE SMELL OF PRIVIES.

In ſome houſes, privies, when badly placed and ill taken care of, diffuſe an odour as inconvenient as unhealthful; but the means of remedying this evil is exceedingly eaſy. If a certain quantity of milk of lime (water in which lime has been diſſolved, and whitened by the fine particles of that ſubſtance) be mixed with a ley of aſhes, or ſoapy water that has been even uſed for waſhing, be thrown into the ſink of the privy, it will deſtroy the offenſive ſmell. By theſe means, for the value of a few pence, any collection of filth whatever may be neutraliſed. By the ſame proceſs conveniencies for ſick perſons may be kept in their apartments. Nothing is neceſſary but to have a tub covered with a board as a ſeat; five or ſix pounds of quicklime, a ſmall quantity of aſhes, and two buckets of water thrown into the tub, will prevent any diſagreeable odour. It may readily be conceived that the ſame proceſs may be employed in regard to a night-

chair. The fecal matter, after being thus neutralifed, is an excellent manure for land.

LENGTH OF THE METRE.

From the Journal de Phyfique we learn, that the report which has been made of the length of the metre at Paris by the learned men employed in determining the length of a degree of the meridian, has been fixed at 3 feet 11 lines and 1,296 of a line. On this bafis all the other meafures are to be formed. We fhall give hereafter a more particular account of this operation, which leads to fome changes in the refults before given by approximation.

TRANSIT OF MERCURY.

" I waited with impatience for the paffage of Mercury over the fun's difk in his defcending node. It had never been completely obferved in that pofition, and there will not be another for thirty-three years. I had the pleafure of obferving Mercury enter the fun's difk, like a fmall round black fpot, on the 18th of Floreal (May 7th) in the morning, at the very moment pointed out in my new tables. The principles on which they are founded I have explained in the firft memoir read at the firft meeting of the firft clafs of the Inftitute immediately after its eftablifhment. This is the more fatisfactory, as, in the calculations for the tranfit of the 4th May 1780, there were forty minutes variation from the beft tables of Mercury. LALANDE."

PREPARATION OF BRUNSWICK GREEN.

Kaftelcyn has lately publifhed the following method of preparing this colour, which is much ufed on the Continent for oil painting, and in the manufacturing of printed paper. Shavings of copper are put into a clofe veffel, and befprinkled with a folution of the muriat of ammonia. The metal firft unites with the muriatic acid, and is diffolved, and is in its turn precipitated by the difengaged ammonia, to which it now joins itfelf. The precipitate is then waffied

and dried in wooden boxes, or upon an extended cloth. The liquid which remains, as well as the water of the firſt waſhing, may be employed ſeveral times in ſucceſſion for new operations, by diſſolving in it freſh portions of ſal ammoniac to the point of ſaturation. Three parts of the muriat of ammonia are ſufficient for two parts of copper, and the reſult is ſix parts of colour. This beautiful green is in Holland called Frieſland green. It is almoſt always adulterated with ceruſe.

CEMENT FOR FILLING UP CRACKS AND FISSURES IN IRON VESSELS.

The ſame author has alſo made known this cement. It conſiſts of ſix parts of yellow potter's clay, one part of the filings of iron, and a quantity of linſeed oil ſufficient to form the whole into a paſte of the conſiſtence of putty.

GREN'S EUDIOMETER.

Profeſſor Gren, in a work of his lately publiſhed *, propoſes the following method of conſtructing an eudiometer by means of phoſphorus; which, though ſlow in its operation, will give a very accurate reſult. Take a ſmall cylindric glaſs tube, ſealed at the one end, and divided from that end by means of a ſcale into ſufficiently ſmall equal parts; fill it with diſtilled water, plunge it into a baſon of the ſame liquid, make to aſcend a quantity of the air to be examined, and note the ſtate of the atmoſphere at the time, as indicated by the barometer and thermometer. Through a cork, ſmaller in diameter than the tube, ſtick a few needles, and place on the upper end of them a bit of pure clear phoſphorus: faſten a thread to the bottom of the cork. Introduce this cork into the lower end of the tube, with the phoſphorus uppermoſt, in which it will riſe to the ſurface of the water; ſo that the phoſphorus on the needles will come in contact with

* Grundriſs der Naturlehre. Halle, 1797.

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the gas in the upper end of the tube. The tube muſt now be left inverted in the veſſel filled with water, in which it muſt remain. The phoſphorus will undergo a ſlow and gradual combuſtion: by means of the thread the cork from time to time may be drawn under the water to waſh off the acid produced by the combuſtion, and, adhering to the phoſphorus, to haſten the proceſs. When all the oxygen gas is conſumed, and the remaining phoſphorus is no longer obſerved to ſhine in the dark, the cork muſt be drawn out; and the obſerver muſt note, at a correſponding height of the barometer and degree of heat with that of the atmoſphere when the proceſs commenced, the quantity of azot remaining, and how much oxygen has been conſumed.

METHOD OF PROVING WHETHER COTTON BE ADULTERATED WITH WOOL, or *vice verſa*.

You may eaſily aſcertain whether cotton is mixed with wool, by ſubjecting it to the action of the oxygenated muriatic acid, which will render it white, at the ſame time that it makes the wool yellow. Profeſſor Brugman, of Leyden, has by the ſame means been able to determine with certainty what part in the brain is the medullary ſubſtance, and what part the nerves; and to diſcover the latter even at their origin, where moſt concealed.

OXYGENATION OF SNOW AND RAIN.

In our laſt volume, page 233, we gave a paper by M. Haſſenfratz on the oxygenation of ſnow and rain, and their effects on vegetation. In that paper M. Haſſenfratz divides the action of ſnow into parts. 1ſt, As preſerving plants from the great cold of the atmoſphere; 2d, as cauſing a greater number of ſeeds to expand by means of the oxygen with which it ſupplies them. M. Haſſenfratz proved the preſence of oxygen in ſnow by its rendering turnſol paper red, and precipitating oxyd of iron from a ſolution of the ſulphat of that metal. Dr. Joachim Carradori

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de Prato has, however, lately aſſerted *, in oppoſition to M. Haſſenfratz, that ſnow is not oxygenated: 1ſt, becauſe fiſh which lived very well in common water, did not live in recent ſnow water, but died in a ſhort time: 2d, becauſe ſnow water expoſed to the action of light did not ſuffer oxygen gas to be diſengaged. He aſcribes therefore the ſudden death of fiſh, and the non-production of oxygen by light, to the want of that ſubſtance in ſnow water. M. Haſſenfratz has obſerved, in anſwer to theſe objections, that animals may die either through the want or by an exceſs of oxygen, as well as by the want or an exceſs of nouriſhment, and that a mean proportion of both are neceſſary for the preſervation of life and health: that all oxygenated ſubſtances do not diſengage their oxygen on being expoſed to the light; and that when it is diſengaged, they ſuffer only the exceſs to eſcape—another portion remains which cannot be taken from them by that agent. Dr. Carradori," ſays M. Haſſenfratz, "does not deny the reſults of the experiments I have announced; he only thinks they are not concluſive, becauſe fiſh do not live in recent ſnow water." He therefore promiſes, as ſoon as he can procure ſnow water, to repeat Dr. Carradori's experiments; to vary them, and make new ones, in order to prove in the moſt poſitive manner the exiſtence of oxygen in ſnow, and to determine the cauſes of the phenomena which ſeem to belong to it excluſively.

EUROPEAN SUGAR.

We are informed by Profeſſor Beckmann, that the Chamber of the Mark at Berlin has lately been at great pains to promote the manufacturing of ſugar from plants indigenous in Germany. Some experiments were made for that purpoſe with the juice of the maple, which was refined in a ſugar bakehouſe, and found to be equal to loaf ſugar. Profeſſor Beckmann, who ſaw ſpecimens of it, ſays, it has been found

* See his experiments in the *Journal de Phyſique*, Ventoſe, an. 7. p. 226.

that

that the Virginian red maple, or ſilver-leaved maple (*acer rubrum*), gives more ſugar than the ſugar-maple (*acer ſaccharinum*); which is the more fortunate, as the latter withſtands better the cold of an European winter. The Profeſſor adds, that attempts are making in Brandenburg to cultivate this tree, and that ſeeds have been ordered from America, but they have not yet arrived.

ERUPTION OF THE PEAK OF TENERIFF.

Fleurieu lately announced to the National Inſtitute, that a ſea-captain had actually ſeen the Peak of Teneriff throwing up fire. According to La Cepede, no eruption from the Peak has taken place for 400 years. Fleurieu himſelf had often ſeen ſmoke ariſe from it, and found the earth near the crater ſomewhat warm.

TORNADO.

The following account of a phenomenon of this kind, which took place at Whitelaw, in the pariſh of Ednam, Berwickſhire, on the 3d inſtant, is copied from the Kelſo Mail:—

"The weather through the day had been calm, with ſoft ſhowers. At ſeven o'clock in the evening there was obſerved by many people, a little to the ſouth-weſt of Mr. Tod's houſe at Whitelaw, a denſe light-coloured cloud of a very uncommon appearance. It reſembled an inverted cone, reaching from the ground to a conſiderable height in the atmoſphere. Its motion towards the houſe was ſlow and majeſtic; a perſon of no great agility, on ſeeing it approach, could eaſily have eſcaped from it. It began at length to whirl round with great rapidity, accompanied by a loud rattling noiſe. The effect of its amazing power was firſt exhibited upon a large ſtack of ſtraw in the barn-yard, which it raiſed in one maſs to a conſiderable height in the air. A beam of timber, lying flat on the ground, was hurled from its place ſeveral feet; and it will be thought almoſt to exceed credibility when it is mentioned that this beam was 33 feet long. Small ſtones were heaped together

together in mounds, as if by a flood. The farm offices were materially injured; fome of them, indeed, were almoft entirely ftript of their tiles. Human ftrength was mere weaknefs when oppofed to this war of the elements. A ftout young fellow, who had witneffed the fcene in the barn-yard, from an apprehenfion that the houfe muft neceffarily be tumbled down, ran out for fafety. The refiftlefs enemy, however, lifted him over a wall five feet high, and carried him forwards 30 or 40 yards! Several of the fervants were forcibly driven about, fome in one direction and fome in another, according to the eddy. The horfes and cattle upon the farm exhibited the livelieft fymptoms of alarm and agitation. The dwelling-houfe at Whitelaw, in which the family refided at the time, fhook with fuch violence as to threaten its own deftruction and theirs. Providentially, however, amidft all the devaftation, no perfon was materially hurt; and, what renders this the more remarkable is, that the tiles which were torn from the furrounding offices fell from an immenfe height, in vaft numbers, among the people expofed to the ftorm. Before the cloud reached the farm-houfe it had fortunately divided, and the two parts taking different directions, only one of them ftruck the buildings. Had the whole collected force difcharged itfelf at once, few, it is probable, would have furvived to relate the particulars. There was little rain at Whitelaw either immediately before or after the whirlwind; but in the adjacent country, to the north and eaft, owing, it is fuppofed, to the violent concuffion of the clouds, there was fuch a torrent of rain, and, in fome places, of hail for a few minutes, as had not been obferved in the memory of man."

DEATHS.

After a few hours illnefs, on Saturday July 6th, at his houfe in Oxford-ftreet, Revely the architect; a man of great attainments in his fcience. He had followed the fteps of Athenian Stuart in his travels through Greece and

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reſidence at Athens, and had availed himſelf of all the advantages which might be derived from viſiting the architectural remains in that part of the eaſt. His collection of drawings, which were made during his oriental progreſs, are univerſally known to all the lovers of art and admirers of claſſic antiquity.

His principal work is the New Church at Southampton, which poſſeſſes great merit as it is; and would have been a very diſtinguiſhed monument of his talents, if his original deſign had been completed; but he was curbed and controuled in its progreſs by his employers, the mayor and aldermen of that borough.

His plans for wet docks on the Thames, which were offered to the conſideration of Parliament, diſplay a very comprehenſive knowledge of the various branches of his profeſſion connected with ſuch an undertaking. We have heard that he firſt ſuggeſted the converſion of the Iſle of Dogs to that uſe to which there is an appearance that it will now be applied. Theſe plans he ſometimes thought of publiſhing, with large explanations and technical accounts of every part; but we know not how far he had proceeded, or whether he had proceeded at all, in fulfilling ſuch an intention.

He was once tantalized with the flattering expectation of being employed at Bath in erecting a ſuite of buildings for a new arrangement of the public baths in that city. He accordingly made deſigns of great beauty and elegance, replete with convenience, full of rare contrivance, and diſpoſed in an original ſtyle of accommodation. But this hope paſſed away, as Mr. Revely's hopes were very apt to do. He was alſo the Editor of the poſthumous volume of Stuart's Antiquities of Greece, and was peculiarly qualified, by his local and profeſſional knowledge, for that office.

He had been a pupil of Sir William Chambers, and, with all the ſubſequent advantages derived from travel and reſidence in Italy and Greece, it might have been ſuppoſed that he had a very fair proſpect of ſucceſs in his profeſſion. But

Revely had an awkward way of letting loose his real opinions, and had habituated himself to an undisguised delivery of them. It need not be added, that such qualities were not calculated to render him popular, and that they influenced many who were disposed to employ him to seek architects of more pliant and accommodating dispositions.

He entertained a very high opinion of the profession of an architect; but it did not check his industry by any supercilious affectation of importance, for he sought employment wherever a liberal spirit would permit him to seek it. This activity, however, appears from some untoward circumstance or other to have been continually baffled. He once made a journey to Canterbury, with a set of admirable designs for a county infirmary, in consequence of an advertisement from the corporation of that city, which invited architects to make proposals for the erection of such an edifice. His designs were approved and admired; but after some consideration, the committee appointed to conduct the business proposed to purchase the drawings, and trust the execution of them to a country builder in order to save the expence of an architect. Mr. Revely, mortified at this treatment of his professional character, rather warmly, but very innocently observed, that to commit a work of such consequence to a common carpenter, when an architect was at hand, would be as injudicious as if any one, in a case of great danger, should apply to an apothecary when he could consult a physician. Now, it most unfortunately happened that the chairman of the committee was an apothecary; and Mr. Revely was astonished to find himself and his designs very unceremoniously dismissed, to make room for a builder who probably was not qualified to suggest such frivolous distinctions.

We cannot conclude without giving this accomplished architect the best praise that can be bestowed. He was a man of strict integrity in all his dealings; and the little eccentricities of his character had no tendency to weaken the main supporters of it.

In

In Vol. III. p. 335, we announced the death of the celebrated French aſtronomer Borda on the 20th of February laſt in the 64th year of his age. Since that period we have been able to collect a few more particulars reſpecting the ſervice rendered by him to the ſciences, which will no doubt afford ſatisfaction to many of our readers. Charles Borda, formerly Chevalier de Borda, was a *Chef d'Eſcadre* in the Royal Navy under the old French government. He diſtinguiſhed himſelf early as an able mathematician, and many proofs of his talents in this reſpect may be found in the numerous and excellent papers which he publiſhed in the Memoirs of the Academy of Sciences. He wrote on different objects of hydraulics; on the reſiſtance of fluids; on water-wheels and pumps; on the throwing of bombs; on the method of determining curved lines; on the properties of *maxima* and *minima*; on the beſt method of chooſing by lot. In the year 1771 and 1772 he undertook a voyage, by command of the king, with Verdun de la Crenne and Pingré, in the Flora frigate, in which he had the rank of *Lieutenant de Vaiſſau*, to various parts of Europe, Africa, and America, for the improvement of geography and navigation, and in order to try various nautical inſtruments and time-pieces. Theſe three navigators afterwards publiſhed, in concert, the reſult of their obſervations, in two volumes quarto, under the title of *Voyage fait par Ordre du Roi en* 1771 *et* 1772, &c. in which Borda's ſhare was not the leaſt conſiderable. An account of the reſult of this expedition may be found alſo in the Memoirs of the Academy of Paris for the year 1773. The public are indebted to him likewiſe for the beſt chart of the Canary Iſlands, which ſerved as a pattern for the valuable chart of theſe iſlands publiſhed in Spain in 1788.

In the year 1787 he publiſhed his valuable *Deſcription et Uſage du Cercle de Reflexion*, in which he revived the reflecting circle propoſed by Tobias Meyer in 1756. He was the founder of the firſt ſchool for Nautical Architecture in France, and drew up a plan of the mode of education to be employed

employed in it. He introduced alſo an uniformity in ſhip-building according to the principles of Euler, by which means all the French ſhips of war were ſo conſtructed as to be equal in point of ſailing. The form of the French ſhips, which is founded on true mathematical principles, is undoubtedly ſuperior to that employed by other maritime nations: it is the moſt convenient and advantageous for quick ſailing, as has been acknowledged even by ſome of the beſt officers in the Britiſh Navy. He brought into uſe Meyer's old method of meaſuring terreſtrial angles, which had been totally neglected; employed it in aſtronomical obſervations, and invented a circle on a new conſtruction with moveable teleſcopes, which was uſed in the new meaſurement. He was the inventor of the new inſtruments with which that meaſurement was made, and of which ſome account has been given in the firſt volume, p. 269, of this Magazine. He had the greateſt ſhare in the late reform of weights and meaſures introduced in France; and cauſed to be printed, at his own expence, tables of ſigns according to the decimal ſyſtem. In the year 1792 he determined, with an accuracy never before attained, the length of a pendulum ſwinging ſeconds, at Paris. In the year 1797 he ſtood on the liſt of candidates for the directorſhip.

The following anecdote is related of him when a young man:—Having preſented himſelf before Camus, who examined the ſtudents in the Artillery School, as a candidate for admittance into the Royal Artillery, he was rejected on the ſcore of incapacity. It was not long, however, before he was a colleague in the Academy of Sciences with his former examiner, who had entertained ſuch a falſe opinion reſpecting him. Borda, however, either through a love of truth, or reſpect for his *quondam* judge, who was now his fellow-member, always contradicted this anecdote, and called it an idle rumour.

Errata. In our laſt Number, p. 89, l. 14, *for* three *read* two. Page 90, 4th line from the bottom, *read*—that appear as if upon his body, and having, &c. . Page 92, l. 23, *for* milla *read* metal.

THE

PHILOSOPHICAL MAGAZINE.

AUGUST 1799.

I. *Observations on the Property ascribed to Oil, of calming the Waves of the Sea.* *By* I. F. W. Otto *.

An idea was entertained, in the earliest ages, that there were means capable of calming the waves of the restless ocean, and of rendering its surface tranquil and even. Aristotle says, that every body thrown into the sea when agitated, such as anchors, &c. tends to lessen the waves; because a kind of eddy is thereby created, which exerts itself in a direction contrary to their movement, and consequently weakens them. Plutarch † and Pliny ‡ ascribe this power to oil; as they assert that it possesses a property by which it restrains the restless movement of water, renders its surface even, and thereby causes the rays of the sun, which are refracted through the waves in different directions, to pass to the bottom free and uninterrupted. What the ancients have said on this subject is exceedingly vague and obscure. It

* From Von Zach's *Geographische Ephemeriden*, Vol. II. Part 6.

† Quæst. Nat.

‡ Ea natura est olei, ut lucem adferat et tranquillet omnia, etiam mare, quo non aliud elementum est implacabilius. *Hist. Nat.* lib. ii. c. 103.

does not appear clearly from their information, whether the divers, to whoſe teſtimony they refer, made their obſervations at the ſurface of the water, or at any depth. Beſides, we are not able to aſcertain whether they looked through the oil as through a window, or as through a magnifying glaſs: for if a drop of limpid oil be let fall upon water, it will form a very ſimple kind of microſcope, and magnify objects placed at a convenient depth below the water. Plutarch ſeems to believe, that the oil ſpouted from the mouth of the diver formed, in aſcending, a kind of canal, which facilitated the paſſage of the light through the water *.

Of this property of oil, apparently ſo wonderful, many teſtimonies were afterwards produced; and it was even conſecrated by ſuperſtition for this purpoſe. Thus we are told, among the miracles of St. Cuthbert, that he gave a prieſt, for a ſea voyage, ſome conſecrated oil, by which he was enabled to allay the fury of the waves during a dreadful ſtorm. Eraſmus was acquainted with this property†; and at preſent it is not unknown among ſeamen, particularly in Holland.

Not many years ago, but before the celebrated Franklin communicated to the public his obſervations on this ſubject, the following article appeared in the *Annual Regiſter*:—"At the late fire in Thames-ſtreet it was obſerved that the oil, which, to prevent the farther ſpreading of the fire, had been thrown into the river, viſibly calmed the violent agitation of the water. This property of oil," ſays another paragraph, "appears to have been long known. It is ordered, by an old marine law, that when goods, during a ſtorm, muſt be thrown overboard, if any part of the lading conſiſts of oil, it ſhall be the firſt article thrown into the ſea." In modern times we have a number of experiments which ſeem to leave no doubt reſpecting this circumſtance. I ſhall

* Caniſius Lect. Ant. Vol. II. p. 8. ed. Baſn.

† His words are: Nonnulli procumbentes in ſabulas adorabant mare, quicquid erat olei effundentes in undas. *Colloq.* e recenſ. P. Rabi. Ulm. 1747-8, p. 262.

here

here give an account of the moſt ſtriking of them, without any fear of being thought too circumſtantial, as experiments of this kind ſhould all be deciſive.

The inhabitants of the Bermudas employ oil in their fiſheries, in order to render the water of the ſea clear and tranſparent; and the Portugueſe ſailors, when they find the waves too violent on their entering the Tagus, pour a few flaſks of oil into the water, by which means it is rendered calm, and their entrance becomes eaſy. The divers in the Mediterranean, when they labour under water, and when the ſun-beams are prevented from penetrating to them by ſmall waves, are accuſtomed to ſpurt a little oil from their mouths. One Gilfred Lawſon, who reſided ſeveral years at Gibraltar, relates, that the ſeamen of that place were accuſtomed to pour a little oil into the ſea, in order that they might thereby be enabled to diſtinguiſh the oyſters at the bottom; and that the ſame practice was followed on the whole Spaniſh coaſt. The ſame thing is done on the coaſt of Provence, and alſo by the inhabitants of the Hebrides. The Raguſans, with the like view, are accuſtomed to ſprinkle oil over the water with a bruſh; and they give to the drops, under which the water becomes tranſparent, the name of windows. Tys Tiremann, a Dutch mariner, made an experiment of this kind during a ſtorm, after he had loſt his rudder and ſome of his ſails, and, with ſix half ankers of oil, calmed the fury of the waves. A lieutenant of the name of May obſerved in 1735, during a ſtorm, that the ſea was calm and ſmooth around two ſhips laden with caſks of oil, ſome of which were leaky; and an experienced ſeaman, named Bewerwyk, recommends, for ſecuring boats which might be ſent to the aſſiſtance of ſhips in diſtreſs, to throw into the ſea, oil and other fat ſubſtances, and even beer. In a deſcription of the ſhipwreck of a veſſel called the Anna Cornelia, this property of oil is alſo celebrated; and ſome experiments made at Portſmouth, in the time of a ſtorm, were attended with the beſt ſucceſs. In the year 1736 Detouches de la Frenaye

ſaw an old ſailor, by this method, ſave a ſhip which was on the point of foundering. One Day was indebted for his own ſafety, and that of his ſhip, to half a ton of oil. Linnæus* learned from Gronovius, that the Dutch captains who frequented Greenland, and who were reproached with concealing this property of oil, always carried ſome caſks of it with them when they went to the whale-fiſhery. The fiſhermen of the Texel carry oil with them for the like purpoſe. There is an inſtance of a herring-buſs being ſaved by pouring out oil; while another, at the diſtance of two or three hundred fathoms, went to the bottom. Not only oil, under which is to be underſtood fat oil, ſuch as olive oil, oil of rape-ſeed, and linſeed oil, may be employed for this purpoſe; but alſo fat animal fluids, ſuch as train-oil, &c. Ethereal oils do not poſſeſs the ſame property: a ſhip, for example, laden with oil of turpentine, which ſhould employ it with the like view, would certainly fail in its end. This oil, however, diffuſes itſelf very ſpeedily over the ſurface of the water; but the covering it forms is ſo thin that it is ſeparated by the ſmalleſt external force.

At Yarmouth the ſailors are unanimouſly of opinion, that fat ſubſtances thrown into the ſea prevent the agitation of the waves. Pennant† mentions an obſervation made reſpecting ſeals by the fiſhermen in Scotland. When theſe animals eat any fat fiſh, the ſea in their neighbourhood is uncommonly ſtill; a circumſtance which induces them to ſearch for them in ſuch places. Sir John Pringle learned in Scotland, that the fiſhermen could diſcover at a great diſtance places much frequented by herrings, as the ſea, by the oily fatneſs which theſe fiſh emit, has no apparent movement. It is obſerved at Rhode Iſland, that the water in the harbour of Newport is always calm and ſtill as long as the Greenland ſhips remain there at anchor. The cauſe of this is aſcribed

* Reiſe durch Weſtgothland, p. 304.

† Britiſh Zoology Vol. IV.

to

to the ſea-nettle, a kind of vegetable ſea-worms from oily ſubſtances, which are thrown together in the hold of the ſhips, and the oil that oozes through between the ſtaves of the caſks, which, of courſe, is pumped out with the bilge water. Seamen have alſo obſerved, that the motion of a ſhip, the bottom of which has been newly payed, occaſions much leſs agitation in the water than that of another which has not been daubed over with tar for a long time. Such inſtances, of which ſeveral more equally deciſive might be produced, are ſufficient to authoriſe this uſe of oil, in oppoſition to thoſe who pretend that it can be employed only in ponds and other pieces of water of ſmall circumference, where, by diffuſing itſelf over a maſs of water not much ſwelled up, it can eaſily produce a tranquil ſurface.

Theſe facts ſeem to have been unknown to Dr. Franklin until he had an opportunity of making ſimilar obſervations himſelf. On his paſſage from England to America ſome perſon told him that he had thrown into a lake a veſſel containing oil in which flies had been drowned; that the flies, which were apparently dead, began in an inſtant to move, and went round with a circular motion on the ſurface of the water. Dr. Franklin aſcribed this movement to a repulſive power maintained by the oil, which gradually iſſued from the ſpongy bodies of the flies. In the year 1757, being at ſea in the middle of a fleet conſiſting of ninety ſhips deſtined for Louiſburg, he obſerved that the movement of the water was in one part of the fleet calm and uniform, while the water between the other ſhips was thrown into great agitation by the wind. As he could not at that time diſcover the cauſe of this phenomenon, he aſked the captain of one of the ſhips, who replied, that the cook had, no doubt, thrown out the greaſy water, which muſt have rendered the ſides of the ſhip oily.

Franklin now paid more particular attention to this circumſtance; and as he found that a drop of oil diffuſed itſelf

ſpeedily over a large ſpace of water, ſo that it formed a thin covering to it, which reflected priſmatic colours, he reſolved to make ſome farther experiments; and though they did not all ſucceed according to his wiſh, he declared himſelf convinced of the truth of the phenomenon.

One of theſe experiments I muſt here mention; for, though it does not appear very favourable to his ideas reſpecting the efficacy of oil in calming the waves, it at any rate ſhews that oil has a great influence on the motion of water. He diſcovered that oil excites on the water a kind of waves, under circumſtances when neither water alone nor oil could produce the like. He ſuſpended a glaſs half filled with water, and having made it to ſwing backwards and forwards, after the manner of a pendulum, the water remained at perfect reſt. The caſe was the ſame when the glaſs was half filled with oil; but as ſoon as he had poured oil upon the water, and continued the ſwinging of the glaſs, the ſurface of the vibrating oil remained ſmooth and even, while the water below it was thrown into a regular agitation like that of the billows of the ſea.

Franklin conſiders this phenomenon, which I have confirmed by experiments, to have in it ſomething ſingular, and difficult to be explained. The cauſe of it, however, may perhaps lie in the difference of the ſpecific gravities of theſe two fluids, by which they are ſuſceptible of the impulſe to movement in different degrees; and by the effort which the oil makes, on account of its lightneſs, to occupy the upper place on the ſurface, the water is violently agitated.

When a drop of oil is poured upon water in a ſtate of reſt, as for example in a baſon, a fine vapour immediately ariſes and covers the ſurface of the water. It emits coloured rays, and diſperſes ſmall bits of paper thrown upon the ſpreading drops. When the ſpace on which the drop falls is ſmall, it does not ſpread itſelf; but ſeems, as it were, to be attracted towards its centre. When a bit of paper, twiſted together

in

in a conical form, and ſoaked in oil, is thrown into water, the fluid which iſſues from it cauſes it to turn round with a rotary motion on its centre.

In an experiment which Franklin made on a ſmall lake, the ſurface of which was raiſed into large waves by the wind, the oil ſpread itſelf with great velocity, but it did not moderate the waves. The reaſon of this was, that he poured out the oil at the leeward ſide of the lake. He therefore went to the windward ſide, where the waves originated; and there a ſmall quantity of oil produced, in the ſpace of ſeveral ſquare rods, a calm, which gradually extended farther until it reached the other end of the lake; and this whole part of it, for the extent of half an acre, ſoon became as ſmooth as ice.

Of the various explanations given of this phenomenon, the following appears to be the moſt natural, if not altogether ſatisfactory:—The air and water have an affinity for each other, and they unite in a mechanical and chemical manner when they come in contact. It is well known that air always exiſts in water; that the latter can be freed from it under the receiver of an air-pump; and that, when the water is again expoſed to the air, it abſorbs a like quantity of it. When a maſs of air preſſes, therefore, on the ſurface of a body of water, it combines itſelf in part with it, and forces it along with it. Now, if oil be poured upon water, the particles of the former attract each other with too great force to admit of their uniting with the water or the air. By the covering which the oil forms on the ſurface of the water, the latter is prevented from coming into contact with the air; and the wind is conveyed over its ſurface, without being able to force its way into it, and to raiſe it into waves.

The ſpreading of oil in water is aſcribed by Dr. Franklin to a repulſive power which they both exerciſe againſt each other: but it is very evident that this explanation is far from being ſatisfactory. Even if ſuch a power actually exiſted, and if the particles of the oil exerciſed a repulſive power

againſt the water, and an attractive power among themſelves, they would be prevented from ſpreading, in an uniform manner, over the ſurface of the water: they would rather form inſulated globules; and, as they touch the water, would equally recede, and proceed towards the bank or any other ſolid body. Oil, therefore, as it is lighter than water, muſt float on its ſurface when poured upon it, and, according to the laws of hydroſtatics, endeavour to extend itſelf in a lateral direction; and on account of the ſtrong adheſion of its particles, muſt form an extraordinary fine and continued ſtratum on the ſurface of the water. This diffuſion, however, ſuppoſes that the ſurface of the water is horizontal: it therefore ſeems to follow, that the whole power of the oil conſiſts in preventing the formation of new waves in the places on which it has been poured; but that it cannot be in a condition to diſperſe thoſe which have been already formed. The billowy agitation of water ſuppoſes that ſome part of its ſurface has been previouſly raiſed. Bodies which float upon it oppoſe this riſing by their gravity, conſequently the billowy movement, and in part deſtroy it.

It appears therefore, to ſome philoſophers, that this celebrated property of oil does not conſiſt ſo much in its fluidity and toughneſs, as in its being a lighter body than water. From this it would follow, that all bodies lighter than water, and at the ſame time more diſtended, ſuch as drops or maſſes formed by oil, muſt produce the ſame effect, but in a higher degree. Achard recommends for this purpoſe cloſe leathern veſſels, through which the water cannot penetrate; or, what would be ſtill better, tin-plate boxes of from ſix to eight feet content in the baſe and two feet in height, which muſt be filled with air, but rendered impenetrable to water. Ships, he thinks, without much increaſing their lading, might always carry with them ſome dozens of theſe veſſels or boxes, to be thrown overboard, faſtened to the ſhip with ropes, in caſe the agitation of the water ſhould threaten danger. Achard made experiments, on a ſmall ſcale, with tin-plate boxes of

this kind, which were attended with the wiſhed-for ſucceſs as when he employed oil: we know alſo, from the information of Scheldenung, that the whirlpool of the Maelſtrom has been moderated by throwing pieces of wood into it.

To form a deciſive opinion reſpecting the utility of theſe means, it would be neceſſary to make experiments upon a large ſcale. At preſent oil appears to me to deſerve the preference, as it produces the effect, not only by its being a lighter body, but alſo by its fluidity and toughneſs: beſides, it poſſeſſes this advantage, that a ſmall quantity of it is ſufficient to ſpread over a conſiderable ſurface of water.

It has been objected againſt this uſe of oil, that the calmneſs produced by it has been obſerved to be only of ſhort duration, and that the ſea afterwards redoubles its fury: alſo, that a veſſel which follows a ſhip ſailing through water calmed by the above means, is expoſed to ſo much greater danger; but of this circumſtance no teſtimony of ſufficient authority has been adduced *.

II. *Communication from Dr.* MITCHILL, *of New-York, ſhewing the Utility of conſtructing the Houſes and paving the Streets of Cities with calcareous in preference to ſiliceous and argillaceous Materials.*

SIR, *New-York, June* 6th, 1799.

IF you think the incloſed letter of any importance, I wiſh you would inſert it in the Philoſophical Magazine. It is ſo

* Tranſactions of the Society of Mancheſter, Vol. II. Achard's *Sammlung phyſikaliſcher und chemiſcher Abhandlungen*, Vol. I. Berlin, 1784, p. 83. *Eſſay ſur les moyens de diminuer les dangers de la mer par l'affuſion de l'huile, du goudron, ou de quelque autre matiere ſtetante, par* M. de Helyveld, Amſt. 1776. Letters and Papers on Philoſophical Subjects, by Franklin, p. 438. *Meiſter de celebratis olei aquæ ſuperfuſi effectibus opticis et mechanicis*, 1778.—The laſt work treats more on the teſtimony of the Ancients, than on the experiments that have been made.

perfectly

perfectly conſiſtent with the principle I have for ſome time been led to receive as true, that I wiſh for its extenſive circulation.

Yours with eſteem and regard,

Mr. TILLOCH. SAM. L. MITCHILL.

Copy of a Letter from Hippolyto I. Da Coſta, Eſq. Braſilian.

" DEAR SIR, *New-York, May* 21, 1799.

" YOUR theory, in regard to the action of *alkalis* and *calcareous earth* upon ſepton, or the principle of corruption, is ſo well proved in the ſeveral papers you have publiſhed, that it is needleſs to adduce further proofs to perſons of knowledge: but as additional facts may be uſeful to perſuade people of leſs information or more prejudices, I believe I agree with your wiſhes in preſenting to you an account of the influence of calcareous earth upon the putrid effluvia in the city of Liſbon, which is, I think, a proof of the moſt intereſting nature.

" The city of Liſbon is ſituated on the northern bank of the river Tagus, about eighteen miles from its mouth: it is about ſix miles in length, and its breadth is in ſome parts two, in ſome three miles, although in other parts very narrow. In the moſt inhabited part of the city there are ſeven hills or mountains, which, of courſe, occaſion declivities and lower ſituations. This city may be divided into the *new* and *old* city; becauſe there is a ſpot which was overthrown by the horrible earthquake of the year 1755, and was rebuilt: I call, therefore, this part the new city. The ſtreets in this quarter are very regular, the buildings neat, and the pavements for foot paſſengers very commodious; but the ſituation is almoſt all very low.

" The old city, or the part which did not ſuffer ſo much in the earthquake, and preſerves its ancient buildings, is in the Gothic taſte, with narrow and crooked ſtreets, in the moſt of which there are no pavements for foot paſſengers; the houſes are ſo high, that, in ſome of the narroweſt ſtreets, the ſun

cannot

cannot be ſeen but two or three hours every day, viz. from eleven before noon to one after noon. In the new city there are gutters or ſewers below the earth to conduct the water and impurities from the houſes and ſtreets to the river; but in the old city there are none of theſe.

"As the houſes are, in general, five or more ſtories high, and the ſtreets narrow, it is eaſy to conceive the thickneſs of population, and, of courſe, the vaſt quantity of impurity that comes into the ſtreets every day, which, with the water and other liquids poured in likewiſe, keep always there a vaſt quantity of dirt. A great ſum of money is appropriated, I know, and ſome pains taken, to preſerve the cleanlineſs of the city: but without entering into the diſcuſſion how this money is employed or diſpoſed of, which is but very little intereſting to our preſent inquiry, it is true that very often I have been obliged to make a great turn to go a ſhort diſtance, becauſe it was impoſſible to croſs the ſtreet through the dirt; and very often I have ſeen dogs, cats, and other dead animals, lie in the ſtreets.

"There is in every houſe (chiefly in the new city) a privy, with a canal which goes up to the higheſt ſtory; becauſe, as the ſeveral ſtories are inhabited by different families, they want ſuch a convenience in every one: but this canal emits always a very bad ſmell, by the accumulation of impurities within its walls, which, from the form of its conſtruction, cannot be waſhed but with water let in by a ſmall orifice or hole. There is alſo, in many houſes, a place in the inſide of the ſtreet-door for making water, which contributes its portion of bad ſmell; and the houſes are in general not very clean.

"Beſides all theſe ſources of putrid exhalations, there are a great many wharves, and much naked ſhore, which, being uncovered by the ebb-tide, preſent to the ſun a ſurface covered with dirt and ſea-weeds undergoing putrid fermentation. The mouths of the ſewers I have mentioned above go to the wharves, and are likewiſe bare at low water. The fluid

which comes from theſe ſewers contains ſo many infecting matters, that its ſtrong putrid ſmell can ſcarcely be endured.

" After this ſhort deſcription of the police of Liſbon, in regard to its cleanlineſs, every body would draw the inference, that endemical diſeaſes muſt reign, not only in the ſummer, but in the winter time, ſeeing that the accumulation of the dirt in the ſtreets is incomparably greater in the winter than in ſummer. The connection there is between malignant diſtempers and dirtineſs is very well known, and expreſsly marked by Tiſſot (*Avis au Peuple ſur la Santè*, chap. ii. § 7). Happily, Sir, the contrary is the fact: Liſbon is one of the moſt healthy ſituations I know, and its inhabitants do not ſuffer but the *common* diſeaſes to which the human body is ſubjected. Many people go from England and other countries to Liſbon, in certain diſeaſes, to enjoy the benefit of a ſalubrious place, and very often to ſpend the ſummer agreeably in a good and wholeſome climate.

" What then can be the cauſe of this apparently phyſical contradiction between the impurity and corruption in the ſtreets, and the ſalubrity of the air? I confeſs, Sir, I cannot find any explanation of this phenomenon if I reject the the theory of the influence of calcareous earth upon ſeptic fluids, and I can well comprehend the reaſon if I admit it.

" The buildings in Liſbon are all of ſtone, and, in general, of marble of ſeveral qualities, and chiefly the marmor raſilis of Linnæus; and this ſtone is procured in the neighbourhood of the city. All the houſes are white-waſhed inſide and outſide; and the handſomeſt new-faſhioned houſes are plaſtered with a plaſter they call *eſcariola*, a compound of gypſum and other matters, and painted over that compoſition in water-colours. As a number of new buildings are continually erecting, there are, in all the ſtreets, a great many ſtone-cutters hewing the ſtones, and their fragments are ſcattered through the ſtreets. In the time of the earthquakes, as the houſes fall down, the attrition of the ſtones, one againſt the other, breaks them in pieces, reducing many

to

to a powder. The pavements for the foot paſſengers are of large marbles; and, in many parts, the ſoil is calcareous too: in other parts, as the ſtreets are paved with ſmall round ſtones or pebbles, the accumulation of the calcareous powder makes a ſtratum above the ſurface of the ſtreets and public places. When the wind blows hard, there is ſo great a quantity of calcareous powder flying about that it is incommodious to the eyes, and ſometimes is ſo fine that it comes into the houſes even when the windows and ſaſhes are ſhut up.

"Now, to what can I impute the healthineſs of that city but the quality of its calcareous earth? which neutralizes the putrid exhalations, or ſeptic acid, which impregnates the atmoſphere, and thus prevents its bad and fatal effects, preſerving that city, which otherwiſe would be the fountain of peſtilence, and the anti-chamber of death.

"As no other cauſe can be diſcovered of the healthineſs of Liſbon, amongſt its continual putrid infection, recourſe may be had to the climate, and to the temperature of the atmoſphere: but I believe it can be ſufficiently proved, that the cauſe is the influence of the calcareous earth, and not of the climate; becauſe, if this ſalubrity was owing to the climate, all the neighbourhood of Liſbon, which enjoys the ſame climate, would enjoy the ſame healthineſs: but this is not the caſe. On the oppoſite bank of the Tagus, over againſt Liſbon, there are three or four villages, called Almada, Caparica, and Caſſilhas, ſituated on ſmall hills, and ſurrounded by beautiful farms: the buildings there are in general of ſiliceous ſtones, the ſoil is ſandy and in ſome parts clayey, and the ſtreets in theſe villages infinitely cleaner than in Liſbon; but intermittent and remittent fevers prevail in theſe villages and their neighbourhoods almoſt every ſummer, while in the mean time Liſbon is perfectly free. Near the other part of the river, in the neighbourhood of Liſbon, on the ſhore of the ocean, there are other ſmall villages, as Cintra and Collares, from whoſe neighbourhoods the ſtone

of

of the Liſbon buildings comes, and the ſoil is in a great part calcareous. Theſe places are pointed out as the ſeat of health, and, indeed, are the moſt beautiful and pleaſant ſummer retreats you can imagine.

"After this ſtatement, can any body attribute the ſalubrity of Liſbon to its climate merely? Certainly not: becauſe I obſerve, that where there is calcareous earth there is no infection, notwithſtanding the continual exiſtence of putrid exhalations; and where there is not calcareous earth, and the ſoil is ſandy, gravelly, and clayey, there are fevers, although the climate is the ſame; the diſtance of theſe places being only the breadth of the river, about three miles.

"To theſe unanſwerable facts I muſt add, that I have obſerved, two or three times, in Liſbon, dead animals upon the ruins of houſes, and of courſe ſurrounded with calcareous earth, in a ſtate of deſiccation; and, at the ſame time, two or three fathoms diſtant, another animal dead too, and lying upon another kind of ſoil, in a ſtate of complete putrefaction. The reaſon of their preſervation is obvious: the ſeptic acid was abſorbed by the calcareous earth as ſoon as it was formed by the union of ſepton with oxygene; likewiſe, the oil formed by the union of their hydrogene with carbone has been imbibed, the water formed by the junction with oxygene evaporated, and the remaining parts of the animal were left in a dry ſtate.

"The effects of calcareous earth and alkalis ſeem to be very well underſtood by the people of Portugal: they put chalk and plaſter with the bodies they bury in the churches; and they waſh with plaſter the rooms where there have been any ſick or contagious diſorders. This precaution they never omit.—I pray you to accept my beſt wiſhes.

"I am, dear Sir,

"Your's, very ſincerely and affectionately,

"HIPPOLYTO I. DA COSTA.

"SAMUEL L. MITCHILL, Eſq."

III. *An*

III. *An Account of Mr.* BROWN's *Travels through Egypt and Syria,* &c.*

MR. BROWN arrived in Egypt on the 10th of January 1792, after a paſſage of twenty-ſix days. Some information which he obtained in Alexandria having induced him to attempt exploring the veſtiges of the temple of Jupiter Ammon, he procured an interpreter, and made the neceſſary arrangements for the conveyance of his baggage and proviſions, with ſome Arabs, who are employed in tranſporting through the deſert dates and other articles between Siwa and Alexandria. In this buſineſs he was much aſſiſted by Mr. Baldwin, who readily entered into his views, and did every thing in his power to promote their ſucceſs.

On the 24th of February Mr. Brown, accompanied by the Arabs, left Alexandria, and travelled the firſt day only about eight miles. From that period till the 4th of March their route lay along the coaſt, and they were never long out of ſight of the ſea. The ſoil was generally ſmooth and ſandy, and the vegetation was very inconſiderable; the greater part conſiſting of different kinds of glaſs-wort or *kali,* which, however, afforded a ſeaſonable relief to the ſuffering camel. For their horſes they were obliged to carry a conſtant ſupply of barley and chopped ſtraw. There are ſeveral kinds of preſerved meat prepared among the orientals for long journies. They obviate the inconveniency of ſalt proviſion by uſing clariſied butter. The kind moſt uſed is called *miſhli,* and will keep good for many years. It is brought from weſtern Barbary to Kahira (Cairo).

On Sunday the 4th, having travelled about ſix hours, they arrived at a well where they found a copious ſupply of water; and, having refreſhed their camels, they left the coaſt, and proceeded in a ſouth-weſt direction. From Alexandria to this well the time employed was about ſeventy-

* Extracted from the Account of his Travels juſt publiſhed.

five

five hours and a half. As they had little hope of finding any more water between that and Siwa, they were obliged to uſe all poſſible diligence on the route, ſo that they arrived there on Friday the 9th at eight in the evening.

Siwa, which anſwers the deſcription given of the Oazes, is a ſmall ſpot ſurrounded on all ſides by deſert land. It was about half an hour from the time of their entrance on this territory, by a path bordered with date-trees, that they arrived at the town which gives name to the diſtrict. They diſmounted, and ſeated themſelves, as is uſual for ſtrangers in that country, on a *misjed*, or place employed for prayer, adjoining to the tomb of a *Marabût*, or holy perſon. In a ſhort time the chiefs came to congratulate them on their arrival, after which they conducted them to an apartment, not indeed very commodious, but the beſt they were provided with; and, after a ſhort interval, a large diſh of rice and ſome boiled meat were brought in, the ſchechs attending while the company was ſerved, which conſiſted of Mr. Brown's interpreter, his conductor, two other Bedouins, their companions, and himſelf.

It being diſcovered that Mr. Brown, though in the Turkiſh dreſs, was a Chriſtian, he experienced ſome bad treatment from the populace, and was obliged to confine himſelf to his apartment for two or three days. On the fourth, however, he was allowed to walk abroad and to obſerve what was remarkable in the place. Having walked about two miles he arrived at what they called the Ruins, or *Birbé*; and was ſurpriſed at finding himſelf near a building of undoubted antiquity, and, though ſmall, in every view worthy of notice. It was a ſingle apartment built of maſſy ſtone of the ſame kind as thoſe of which the pyramids conſiſt, and covered originally with ſix large and ſolid blocks that reach from one wall to the other. The length he found thirty-two feet in the clear, the height about eighteen, the width fifteen. A gate, ſituated at one extremity, forms the principal entrance; and two doors alſo, near that extremity,

open

open oppoſite to each other. The other end is quite ruinous; but, judging from circumſtances, it may be imagined that the building has never been much larger than it now is. There is no appearance of any other edifice having been attached to it; and the leſs ſo, as there are remains of ſculpture on the exterior walls. In the interior, there are three rows of emblematical figures, apparently deſigned to repreſent a proceſſion; and the ſpace between them is filled with hieroglyphic characters properly ſo called. The *ſoffit* is alſo adorned in the ſame manner, but one of the ſtones which formed it is fallen within: the other five remain entire. The ſculpture is ſufficiently diſtinguiſhable; and even the colours in ſome places remain. It was mentioned to Mr. Brown, that there were many other ruins near; but after walking for ſome time where they were deſcribed to be, and obſerving that rough ſtones, apparently detached from the rock, were pointed out to him as ruins, he returned fatigued and diſſatisfied. The ſchechs had prepared for them a dinner in a garden, where they were unmoleſted by intruders; and the ſun being then near the meridian, Mr. Brown took the opportunity of obſerving its altitude by means of an artificial horizon. The reſult was not materially different, though in the ſequel he repeated his obſervation: it gave N. L. 29° 12′ and a fraction; the lon. E. F. 44° 54′.

Mr. Brown having found a monument ſo evidently Egyptian in this remote quarter, entertained greater hope of meeting with ſomething more conſiderable by going farther, or of being able to gain ſome information from the natives, or the Arabs, that would fix exactly the poſition of the remains, if any ſuch there were, of the far-famed temple of Jupiter Ammon. He therefore applied to three of the ſchechs who had ſhewn themſelves moſt friendly towards him and his attendants, and having enquired whether they knew of any ruins farther to the weſtward or ſouth-weſt, one of them replied that there was a place (*Araſchié*) where there were ruins, but that it was impoſſible to approach it, as it was

ſurrounded by water, and there were no boats. Mr. Brown ſoon found, from the deſcription, that *Araſchié* was not the Oaſis of Ammon; but, conceiving it ſomething gained to paſs farther weſt, he determined to proceed thither. For this purpoſe it was neceſſary to uſe all poſſible ſecrecy, as the Siweſe were bent on oppoſing his farther progreſs. An agreement was therefore made with two perſons of the poorer claſs of the natives, for a few zechins, that they ſhould conduct him and his attendants to *Araſchié*, and that, if what they ſought for was not there, they ſhould proceed with them to the firſt watering place that they knew of directly to the ſouthward. The remainder of the time he ſtayed at Siwa was employed in combating the difficulties raiſed about his departure; and it was not till Monday, the 12th of March, that he was enabled to commence his journey weſt.

The Oaſis, which contains the town of Siwa, is about ſix miles long, and four and a half or five wide. A large proportion of this ſpace is filled with date-trees; but there are alſo pomegranates, figs and olives, apricots and plantains; and the gardens are remarkably flouriſhing. The inhabitants cultivate a conſiderable quantity of rice, which, however, is of a reddiſh hue, and different from that of the Delta. The remainder of the cultivable land furniſhes wheat enough for the conſumption of the inhabitants. Water, both ſalt and freſh, abounds; but the ſprings which furniſh the latter are moſt of them tepid; and ſuch is the nature of the water, air, and other circumſtances, that ſtrangers are often affected with agues and malignant fevers. One of thoſe ſprings, which riſes near the building before deſcribed, is obſerved by the natives to be ſometimes cold and ſometimes warm. After the rains the ground in the neighbourhood of Siwa is covered with ſalt for many weeks.

Mr. Brown, having left his temporary reſidence, proceeded, himſelf and interpreter on horſeback, his original conductor on foot, and the two men he had hired each on an aſs; but he had not gone far before one of the latter told him that it would

would be neceſſary to return, as the people of the town were in purſuit of them, and would not permit them to go and diſinter the treaſures of *Araſchié*. They nevertheleſs continued their journey for two days, and at the end of that time arrived at the place deſcribed to them. It was not far from the plain of *Gegabib*. Mr. Brown here found an iſland in the middle of a ſmall lake of ſalt water, which contained miſ-ſhapen rocks in abundance, but nothing that he could poſitively decide to be ruins; nor was it very likely that any ſuch ſhould be found there, the ſpot being entirely deſtitute of trees and freſh water. Mr. Brown, however, had the curioſity to approach nearer to theſe imaginary ruins, and accordingly forced his horſe into the lake. The horſe, from fatigue and weakneſs, or original inability to ſwim, ſoon found himſelf entangled, and could not keep his head above water. Mr. Brown fell with him, and was unable to detach himſelf; and when he at length found himſelf on dry ground, the circumſtances he was under prevented him from making any farther obſervation on this iſland and lake.

After viſiting this place, Mr. Brown and his attendants continued their journey ſouth according to the agreement made with the guides, but found the purſuit equally fruitleſs. At the end of the third day, having arrived in lat. 28° 40′, or nearly ſo, they became much diſtreſſed for water: they remained a whole night in ſuſpenſe concerning their deſtiny, when at length a ſupply of that neceſſary refreſhment was found. As they did not, however, diſcover any thing that bore the leaſt reſemblance to the object of their ſearch, they were obliged to think of returning, which they did; and, falling into the ſtraight road from Siwa to Alexandria, arrived at the latter on the 2d of April 1792 *.

Mr. Brown, after remaining ſome time at Alexandria, to

* Mr. Brown ſays, that an opinion has been communicated to him, that Siwa is the *Siropum* of Ptolemy, and that the building deſcribed was probably coeval with the temple of Jupiter Ammon, and a dependency on it. D'Anville ſuppoſes Siwa to be Marcotis.

recover from the effects of his journey, commenced, on the 1ſt of May, another to Raſhid, where he ſtaid five days; and on the 6th of May embarked with a view of proceeding to Terané, a town ſituated on the left of the moſt weſtern mouth of the Nile, at a very ſmall diſtance from the river. From Terané Mr. Brown made an excurſion to view the lakes which produce natron, and to obſerve that production in its naſcent ſtate. One of them was very irregular in its form, ſo that it was not eaſy to ſay what might be the quantity of ground covered with water. It is higher in winter than in ſummer; and, at the period when Mr. Brown viewed it, he could no where diſcover that the breadth of it exceeded a mile: its length might be nearly four. Towards the end of ſummer theſe lakes, it is ſaid, are almoſt dry, and the ſpace from which the water has retired is then occupied by a thick depoſition of ſalt. Not far from the eaſtern extremity a ſpring riſes with ſome force, which much agitates the reſt of the water. Cloſe to the ſpring the depth was far greater than our traveller's height, in other parts it did not generally exceed three feet. The thermometer near the ſpring ſtood at 76, while in the open air it was at 87. The more weſtern lake differs not materially from the eaſtern, in ſize, form, or productions: the colour of the water in both is an imperfect red, and, where the bottom is viſible, it appears almoſt as if covered with blood. Salt, to the thickneſs of five or ſix inches, lies conſtantly in the more ſhallow part. How thick the ſubſtance of natron commonly is in the lake, Mr. Brown did not accurately determine; but thoſe employed to collect it, reported, that it never exceeded a cubit or common pike. Having ſpent two days and part of a third in the vicinity of the lakes, Mr. Brown's attendants grew tired, and he was obliged to return. After a ſhort interval he embarked for Kahira, and arrived there on the 16th of May 1792.

Mr. Brown being determined to undertake a journey to Abyſſinia, employed the greater part of the ſummer, which he

he ſpent at Kahira, in learning the Arabic language; but ſtill judging that he ſhould have occaſion for an interpreter, he took care to provide a Greek, who, beſides his native language, was acquainted with the Turkiſh, Arabic, and Italian: he had alſo with him a Mahommedan of the lower claſs of the Kahirines, who, as belongs to that character, was prepared for every office. Thus provided, he ſet out by water on the 10th of September, and on the 8th day reached Aſſiut. Having ſpent about fourteen days here waiting for a boat, he was at length able to hire one of a moderate ſize; and leaving Aſſiut on the 4th of October, arrived on the 11th at Girgi, formerly the capital of Upper Egypt. On the 17th he arrived at Dendera, the ancient Tentyra, where he ſaw the noted temple, the moſt perfect ſpecimen of Egyptian architecture now remaining. It is in the form of an oblong ſquare, 200 feet by 150, Pococke ſays 145, and is now almoſt buried in the ſand. The ſame night, about twelve, he reached Ghenné, the ancient Cœne or Cœnopolis; and on the 23d came to Akſôr, the ancient Thebes. After paſſing three days in and around theſe ruins, Mr. Brown proceeded on his voyage up the Nile, and on the 31ſt arrived at Aſſûan, the ancient Syene, where he remained three days, contriving, if poſſible, to purſue his route up the river; but a war having ariſen between the Mamlûks of Upper Egypt and the Caſhef of Ibrim, no one was ſuffered to paſs from Egypt to Nubia. The caravans had all been ſtopped for many months, and not even a camel could be procured. Our traveller being therefore conſtrained, with deep regret, to abandon his deſign of penetrating to Abyſſinia by this route, gave up all hope for that ſeaſon, and began to think of returning.

Mr. Brown, therefore, left Aſſûan on the 4th of November 1792, and, proceeding rapidly down the Nile, arrived at Ghenné on the 7th. From Ghenné he made a ſhort excurſion to Coſſir; but he did not think it adviſeable to ſtay long there, as the people were highly incenſed at that time

againſt the Franks on account of the following circumſtance, which had taken place there three or four years before. An Engliſh veſſel, commanded, as is ſaid, by a Captain Mitchel, having moored there, a quarrel aroſe between the crew and the natives reſpecting a ſupply of water, which is a commodity difficult to be procured. From a violent contention blows enſued, and the captain thought himſelf juſtified to fire upon the town; in conſequence of which ſeveral perſons, ſome ſay fourteen, were killed, and much damage done. The natives were exceedingly exaſperated, and ſwore to ſacrifice the firſt Engliſhman that ſhould fall into their hands. Mr. Brown found little to reward him for expoſing himſelf to the danger of this excurſion, except the ſight of ſome curious rocks, which he thus deſcribes:—The roads we travelled in going to Coſſir, as well as in returning, have ſomething in them very remarkable: the rough and lofty rocks of granite and porphyry, with which it is on all ſides environed, have a magnificent and terrific appearance; and the road between them, which is almoſt level throughout, gives the idea of immenſe labour in cutting it. All theſe circumſtances concur in teſtifying the importance Coſſir muſt once have had as a port. In the route we took in going, at certain diſtances, on the higheſt rocks, is obſervable a ſucceſſion of ſmall ſtructures, formed with uncemented ſtones, and which, by the marks of fire within them, ſeem to have ſerved as ſignals. Theſe are numerous, but they are too rude to enable one to fix any time for their erection. They appear to me to be pretty ancient. The red granite is in vaſt quantities; and the chain of rocks, conſiſting of that ſubſtance, appears to extend itſelf in a north and ſouth direction. Huge rocks of porphyry, both red and green, are diſtinguiſhable; and, as appears, more of it in the road we purſued in going than in that by which we returned. I obſerved ruins of alabaſter in both, but particularly in returning. The *verde antico*, it was long before I could diſcover; at length I found it in returning, by the ſigns Bruce had deſcribed. In ſhort,

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the route unfolds a treaſure of marbles that aſtoniſhes the beholder, and demonſtrates, that, on any future occaſion, the quarries may be again wrought, and modern architecture equal that of the beſt ages of Greece or Rome as to richneſs and durability of ornament, if ever it ſhall in juſtneſs of proportion, ſimplicity of taſte, or unity of parts in one ſublime whole, which, indeed, ſeems ſufficiently problematical. On the 21ſt of November Mr. Brown returned to Aſſiut, and on the 30th ſet ſail for Kahira, which he reached on the 8th of December.

[To be continued.]

IV. *Means propoſed for ſaving the Crews of Veſſels ſhipwrecked near the Coaſt. By an anonymous Author*.*

EIGHT or nine years ago, being much ſtruck by an account which I read of the ſhipwreck of twenty-four perſons who periſhed ſo near the ſhore that their cries could be diſtinctly heard, an idea immediately occurred to me, of endeavouring to diſcover ſome means proper for ſaving the crews of ſhipwrecked veſſels, at leaſt under ſuch circumſtances, that is to ſay, at the diſtance of forty or fifty fathoms from the ſhore; for I did not then imagine that it could be done at the diſtance of two or three hundred, as I afterwards diſcovered. I perceived at firſt that the only means to ſave the crew of a veſſel in ſuch a ſtate, would be to eſtabliſh a rope of communication from the ſhore to the ſhip. After examining a number of means, both ancient and modern, I fixed on a bomb or cannon-ball (a bomb I think preferable), to which ſhould be faſtened the end of the rope, extended afterwards in a zig-zag direction before the mortar or cannon, or ſuſpended on a piece of wood raiſed ſeveral feet. But as it was neceſſary to know if the cord would not break by the

* From a late French Journal.

force of the exploſion and the velocity of the motion, I thought it proper to conſult profeſſional men. I wrote to ſome officers of the artillery in garriſon at La Fere, and they almoſt all replied that the rope would infallibly break.

Not ſatisfied with this anſwer, I happily conceived the idea of making the experiments on a ſmall ſcale. I cauſed a piece of the barrel of a muſket to be filed into the form of a ſmall mortar of 18 lines in length internally; and having tied a packthread to a common ball of lead, I made an experiment, which perfectly ſucceeded, as did a great many others which I repeated afterwards even with the ſtrongeſt charges of powder. I communicated this ſucceſs to theſe officers of artillery, who replied, that there was a great difference between a quarter of an ounce of powder and four or five pounds employed for a bomb; and, in ſhort, that the rope would break.

Being deſirous to aſcertain what truth there might be in this aſſertion, I repaired to a large iron furnace, where I remained ten days, and where I cauſed a mould to be formed for a four-inch mortar and a bullet of the ſame calibre: I had them both caſt, and made an experiment with a rope three or four lines in diameter and eighteen ounces of powder, which ſucceeded. I then came to Paris, where, after ſtaying eight months, I obtained an order from government to make my experiments on a grand ſcale even at La Fere, where I had to expect men prejudiced againſt the ſucceſs of my attempts. When I went thither they perſiſted that they would not ſucceed. I knew, however, what I had to depend upon, as I had already made experiments. In ſhort I repeated them, and they completely ſucceeded. The firſt day, nothing being done in a proper manner, ſome of the experiments failed; but things being arranged better next morning, we repeated them ſeven times without once failing, viz. four times with a mortar of eight inches, and three with one of twelve, augmenting each time the charge of the

the powder from the weakeſt to the ſtrongeſt. The ſpectators having judged that this number was fully ſufficient to eſtabliſh the truth of the diſcovery, no more were made.

I ſhall now proceed to other means, which I have deviſed not only for ſaving the crews of veſſels, but alſo the greater part of the cargoes when expoſed to danger near the coaſt.

1ſt, It muſt be remembered, that, in ſuch circumſtances, the only thing neceſſary is to get a cord of communication conveyed to the veſſel in danger. It ought to be remembered alſo, that a veſſel is never caſt away or periſhes on the coaſt, but becauſe it is driven thither againſt the will of the captain, and by the violence of the waves and the wind, which almoſt always blows from the ſea towards the ſhore, without which there would be no danger to be apprehended: conſequently, in theſe circumſtances, the wind comes always from the ſea, either directly or obliquely, and blows towards the ſhore.

A common paper kite, therefore, launched from the veſſel and driven by the wind to the ſhore, would be ſufficient to ſave a crew conſiſting of 1500 ſeamen, if ſuch were the number of a ſhip of war. This kite would convey to the ſhore a ſtrong packthread, to the end of which might be affixed a cord, to be drawn on board by means of the ſtring of the kite; and with this cord a rope, or as many as ſhould be neceſſary, might be conveyed to the ſhip.—It may be readily conceived that I cannot here enter into any detail concerning various circumſtances relating to this ſubject which it might be neceſſary to mention.

2d, A ſmall balloon, of ſix or ſeven feet in diameter, and raiſed by rariſied air, would be alſo an excellent means for the like purpoſe: being driven by the wind from the veſſel to the ſhore, it would carry thither a ſtring capable of drawing a cord with which ſeveral ropes might be afterwards conveyed to the veſſel. Had not the diſcovery of citizen Montgolfier produced any other benefit, it would be entitled on this account to be conſidered as of great importance.

3d, A

3d, A ſky-rocket, of a large diameter, would be of equal ſervice. It would alſo carry, from the veſſel to the ſhore, a ſtring capable of drawing a rope after it. C. Ruggieri, whom I have conſulted on this ſubject, told me, that he made ſome four inches in diameter, which roſe to a great height; and that, with a ſtring attached to them, they would go to the diſtance of four or five hundred fathoms, which is more than would be neceſſary. They may be kept in a ſtate fit for ſervice two years, if depoſited in a dry place.

Laſtly, A fourth plan for ſaving the crew of a ſhipwrecked veſſel, is that of throwing from the veſſel into the ſea an empty caſk with a cord attached to it. The wind and the waves would drive the caſk to the ſhore, and afford the means of eſtabliſhing that rope of communication already mentioned. Each of theſe methods may be improved, but I cannot at preſent enter into any detail *.

V. *On the different Kinds of Cadmia, and particularly thoſe of Zinc and Cobalt. By* I. I. Bindheim *of Moſcow* †.

THE fureſt method of claſſing minerals is without doubt to arrange them, not according to their external characters, but according to their internal component parts. For, though the former in ſome meaſure ſerve for diſcrimination, and are therefore not altogether uſeleſs, they are not ſo preciſe and certain as to form a baſis for a ſyſtem of mineralogy,

* The author of the above papers ſays, that he announced his diſcovery in the *Affiches de Paris* on the 29th of January 1794. However this may be, we know that one of his methods, that of conveying a rope to the ſhore, by attaching it to a bullet or bomb to be afterwards fired from a cannon or mortar, was propoſed a few years ago by a ſerjeant or officer of artillery at Woolwich, named Bell. Some experiments of the ſame kind made at Portſmouth, we believe, anſwered expectation. The uſe of a kite or rocket ſeems to deſerve attention; and we do not heſitate to ſay, that the former could hardly fail of producing the deſired effect. At any rate it might be eaſily tried. Editor.

† From *Neue Nordiſche Beyträge*, by Profeſſor Pallas, Vol. VI.

ſince

ſince the attentive naturaliſt is ſufficiently taught, by experience, that in the mineral kingdom ſubſtances of the ſame genus, though different in external form, conſiſt often of the ſame component parts; and that other bodies of the like kind differ in their component parts, though perfectly alike in their external appearance. As this is the caſe, we can find no better guide to conduct us to an invariable claſſification, arrangement, and definition of mineral bodies than chemiſtry; a knowledge which muſt be united with that of the external characters of minerals.

To give an inſtance of the uncertainty which ariſes when theſe are ſeparated, I ſhall here mention thoſe ores which are known by the name of *cadmia*; for it would ſeem, by the many improper denominations which are often founded on their external characters, as if we were almoſt conducted back to the dark age of Cadmus, from whom the Europeans are ſaid to have firſt learnt the art of fuſing ores on a large ſcale, and from whom, in all probability, the term *cadmia* had its origin. In this reſpect chemical knowledge is a better guide than external characters, and the names thence deduced, and often very improperly; it enables us to define minerals with more accuracy, and conducts us nearer than the latter to the real knowledge of nature in this department, without which all mineralogical knowledge muſt be uncertain and imperfect. As it would be ſuperfluous to ſay more on this ſubject, I ſhall, for the preſent, confine myſelf to the cadmias, and thoſe ores alone which, when decompoſed in a proper manner, and fully purified, yield thoſe metals called zinc and cobalt.

Of Zinc.

Ores that contain zinc are found in numerous varieties and of different forms. Sometimes they are combined with oxygen and the ſulphuric acid; and ſometimes there are found in them, beſides zinc, various foreign component parts, ſuch as argil and ſiliceous earth, a little iron, lead, and,

and, at times, alſo a ſmall portion of copper. In blende the ſulphur is combined with iron, and the particles of zinc are ſcattered through the mixture. The ſo called furnace calamine is obtained by the fuſion of ſome kinds of lead ore when the particles of zinc are ſublimated by ſtrong heat to a cooler place of the furnace called the *zinc ſtool*, where they adhere in the form of a grey or yellowiſh ſtone. In preparing braſs, and other operations of the like kind, the ſublimated zinc calx is collected under the name of *white nicht*; but what adheres lower down, and becomes a hard maſs, is called *grey tutia*; and this ſubſtance, as ſome ſulphureous vapour ſeems to adhere to it the longer it lies expoſed near the ſmelting houſes, becomes, by the effects of the atmoſphere, always more proper for uſe. Beſides the above, we have zinc calx, zinc ſpar, tutanego ore, the laſt of which was firſt diſcovered in China; but I am convinced, by experiments, that a like ore, which is natural flowers of zinc, is found in Germany in the Thomas-ſtollen at Bleiberg. We have alſo zeolite-formed calamine, zinc blende, glittering blende, black blende, reddiſh brown, phoſphoriſed, greeniſh-yellow, white, and yellow blende. Such kinds are found in England, Siberia, China, Sweden, Sileſia, Saxony, &c.

In examining theſe ſubſtances various chemiſts have rendered great ſervice to mineralogy, particularly Brand and Schwab, counſellors of the mines in Sweden; and theſe were followed by Juſti, Pott, Henkel, and, above all, Margraaf, who employed great care and accuracy in fuſing and examining them; but Bergmann, to whom ſcience is ſo much indebted, has given moſt excellent models for the decompoſition of theſe ores. Whether there be native zinc or not, has never yet been fully aſcertained; and we muſt ſtill remain in doubt until the account of its being found in the iſland of Naxos, in the Archipelago, be better confirmed. The zinc ore of Goſlar, that found in Cornwall, and a little of the Swediſh, can be rendered uſeful and pro-

ductive. The zinc obtained from China, under the name of *tutanego*, is considered to be purer than the German, and therefore a small difference is observed in their specific gravities.

The properties of zinc separated from its ore, and purified, are, that it scarcely undergoes any variation in atmospheric air or in water; and that, by the addition of copper, in different proportions, you obtain brass, pinchbeck, prince's metal, Manheim gold, &c. All acids deprive it of its inflammable matter, and dissolve it with effervescence. With the vitriolic acid it gives a crystalline salt, which is sulphat of zinc, or, as it is commonly called, white vitriol. That white vitriol which is obtained not in a crystalline form, but in white masses like refined sugar, contains often a mixture of foreign metallic particles, such as iron, copper, and lead; but it may be purified by adding to a solution of it pure zinc, by which the above metals will be precipitated: if the solution be then filtered, and exposed to crystallise, you will obtain pure white vitriol.

By the nitrous acid, zinc is dissolved with a strong effervescence and in great quantity producing crystals: if you pour alcohol over these and distil them, you will obtain very good edulcorated spirit of nitre. It dissolves also in the muriatic acid, and emits a strong offensive vapour; this clear solution saturated cannot be brought to shoot into crystals: if you reduce it by evaporation to a gelatinous mass, and place it in a retort over the fire, you obtain, in the same manner as when you distil zinc with sal-ammoniac and corrosive sublimate, butter of zinc of a somewhat thick consistence.

It is soluble also in aqua-regia, and by that acid gives a triple neutral salt, in the same manner as sal-ammoniac. It dissolves likewise in concentrated acetous acid, and shoots into crystals: the remaining acids, viz. of sparry fluor, arsenic, borax, sugar, tartar, sorrel, citrons, ants, phosphorus, and fat, exercise an action over zinc also. The alcaline solvents do the same; and the process succeeds best with a concentrated

trated ſolution of the volatile, not cauſtic alcali, during which an efferveſcence is obſerved, and by which the zinc exhibits traces of an acid: the produce is cryſtals of a neutral ſalt.

Flowers of zinc, like zinc itſelf, are ſoluble in an acid; but with this difference, that no efferveſcence takes place. Theſe flowers are produced during the fuſion of zinc in an open crucible, when the heat is increaſed to above 370 degrees. The metal then inflames with a whitiſh-green flame of a dazzling brightneſs, which ſeems to diffuſe over the faces of thoſe preſent a death-like paleneſs; and the metal, by being deprived of its inflammable matter, (united to oxygen,) is converted into a tender calx, which, by the violence of the inflammation, is, on account of its lightneſs, carried upwards like wool or a cobweb. Zinc, calcined in this manner, is called the flowers of zinc, and alſo *philoſophic wool*, not to mention other ſingular appellations of the alchemiſts. During this operation zinc exhibits ſome phenomena, ſuch as the ſmell, the flame, &c. which are ſimilar to thoſe that occur during the combuſtion of phoſphorus; and therefore people were led to ſuppoſe that the phoſphoric acid was contained in zinc. By the above proceſs the weight of this calx is increaſed a tenth part, and, as ſome have remarked, even more, and at the ſame time it becomes fixed. When expoſed on coals to the blow-pipe, it becomes yellow, and on cooling reſumes its whiteneſs, which is a proof that the flowers of zinc are genuine. It can be fuſed into a yellowiſh-brown glaſs, and, by adding the inflammable matter, can be reduced in cloſe veſſels.

In a cloſe veſſel, expoſed to a violent heat, zinc goes over in a metallic form, and by theſe means acquires the property of creaking, when it breaks like tin. It can alſo be brought to ſuch a ſtate that it may be drawn out into thin plates, and be flatted between metal cylinders; ſome ſpecimens of which, by M. Sage of Paris, and M. Kratz of Berlin, I have in my poſſeſſion. Zinc may be combined with the

greater part of metals, but not with lead, iron, or bismuth; and it may be amalgamated with quicksilver. This amalgam of zinc is very proper for strengthening the power of an electric machine, and Higgins has given a prescription for preparing it. In the dry way it has the greatest affinity with copper, and produces with it a more or less yellow composition, which can be obtained by no other metal. In this respect, then, it is essentially different from all other metals, and becomes itself a very useful one, as it is used for brass, pinchbeck, prince's metal, bronze, Manheim gold, and in fire-works, &c.

It is very remarkable, in regard to zinc, that neither sulphur nor liver of sulphur * produces on it any effect; whereas gold, which sulphur cannot overcome, is dissolved by liver of sulphur.

On this occasion I cannot omit making mention of the celebrated alkahest of Respur, who believed, that when he alcalised zinc and rendered it caustic, and had obtained from it a purple-coloured mass, volatile in the open air, he had found out a menstruum, by which he could radically dissolve all metals. A paradoxical position, which was long adopted by the gold-making alchemists, but which has never been realised.

[To be concluded in next Number.]

VI. *Description of an Assay-furnace, with an Apparatus for measuring the Degree of Heat employed. By Mr.* David Mushet *of the Clyde Iron Works. Communicated by the Author.*

In my last paper I mentioned, that, in order to facilitate the operations of the assay-furnace, and to compare the various degrees of heat in which different experiments are

* It has been ascertained that zinc and sulphur can be united; but the process is difficult, on account of the easy oxidation and volatility of the zinc. See *Mem. de Dijon*, 1783.

effected,

effected, I had constructed the pyrometer which I am now about to describe. It can in no point of view be considered as an universal instrument, as its scale will be entirely local, and vary according to the construction and exigencies of the furnace: it possesses, however, this advantage, that after a scale of comparison is formed betwixt it and Wedgewood's, in the manner described in the explanation, the assayer can at any time mark, with considerable accuracy, the degree at which an experiment is effected, and compare it with the degrees of that scale; and if the furnace and apparatus are kept in proper repair, the results will be consistent with former ones.

Description *of the* Furnace.

A A (Plate V.) the pedestal of brick-work on which the furnace is reared. B, the ash-pit. C, a view of the central parts of the grate, with a knee two inches deep and four inches square, for the purpose of receiving a pedestal of fire-clay for supporting the crucible. D D, the section of an iron cylinder, which contains the brick-work, with flanges projecting inwards both at top and bottom: the upper flange contains two grooves for sliding the cover I, (made of cast iron;) and the under one projects so far as to form a support for the bars of the grate. E E, the lining of the furnace, composed of fire bricks. F, the fire-place, three feet deep, ten inches diameter at the grate, and diminishing to nine inches at the top. G, the flue or draught-hole, which communicates with the chimney. H, the chimney (the top broken off to make it come into the plate), which should never be less than 30 feet high, and nine inches square in the passage. K, an oblong rectangular plate, which projects from the top of the cylinder for the purpose of supporting the pyrometer. L L, an iron box with a square bar of steel, which, in expanding, acts upon the lever at the distance of one inch from the fulcrum.

The letters of the horizontal and vertical section refer to the same parts of the furnace.

Descrip-

Description *of the* Pyrometer.

The principle upon which this inſtrument is conſtructed is the expanſion of metal by heat. After ſeveral experiments with copper, iron, and ſteel, I was induced to give the preference to the latter. Copper was found to be too eaſily fuſed, and the ſcale by that means leſs extenſive than was wiſhed. Malleable iron, by being heated in this manner, frequently acquired permanent additional length, and paſſed into the ſtate of ſemi-ſteel. This principle it derived from the contact of the ſurrounding charcoal, introduced for the purpoſe of preventing oxydation from taking place upon the ſurface of the bar. Highly cemented ſteel, when expoſed in this manner to the greateſt heat, acquired no ſenſible increaſe of length: a bar of poliſhed ſteel was therefore adopted.

A correſponds with the plate of iron K in the drawing of the furnace, on which the pyrometer is ſupported. B an upright, on which is ſuſpended the lever. CC the lever, ten inches long from the fulcrum to the extremity, which acts upon the ſcale, and one inch on the other end from the ſame point to a line drawn through the centre of the expanding bar. From this it is obvious, that if the ſhort end of the lever be elevated half an inch by the expanſion of the bar of ſteel, the other end will ſuffer a depreſſion ten times as much, or equal to five inches. Theſe I have divided into 50 degrees, (equal to each other on a tangent of the arch that forms the ſcale DD,) ſo that the moſt minute expanſion in the bar will be viſibly indicated. Should the ratio of ten to one be thought too ſmall, the power of the lever can eaſily be increaſed to 13 or 20, and the ſcale thus greatly enlarged. When the pyrometer is at reſt, the index points at 0°, and its other extremity reſts lightly upon the ſharp point of the ſteel bar. It is therefore requiſite to make the lever nearly an exact balance, by forming its ſhort end ſufficiently weighty to overcome the great length of the other. The ſcale being carried the length of 50 degrees, allows the bar to expand

5-10ths. This, however, will not be the case, though exposed to a degree of heat approaching to fusion. EE are two supports for the scale, attached to the extremity of the plate by means of bolts. FF is a box of wrought iron which contains the bar of steel exactly fitted, with a small allowance for expanding in the thickness. This box is introduced into the lining of the furnace by means of square notches formed in the bricks about two inches from the contact of the fire. The bottom of the box rests upon the under-flange of the cylinder, and its other end rises through the building and iron-cover about two inches. When at first introduced into its place, the space which may remain betwixt the outside of the box and the building is carefully filled with fine charcoal dust, to prevent oxydation by the chance contact of atmospheric air. G is a polished bar of steel 3 feet 2 3-4th inches long and 1-4th of an inch square, the sharp extremity of which acts upon that part of the lever which, when at 0°, measures one inch from the fulcrum. HH, a small box or cover, which fits upon the top of the iron box by means of pins. This is always kept full of charcoal-dust, to prevent the approach of external air, and the transmission of heat from within.

This instrument may be used in conjunction with Mr. Wedgewood's scale. Any given substance may be melted, and the degree marked upon the scale: let this be compared with the degree of heat at which the same substance melts by Wedgewood's scale; then let the greatest degree of heat of the furnace be measured by one of Wedgewood's rolls, and compared with that pointed out by the index, the one difference divided by the other will give a scale of comparison.

It will hardly escape the notice of men of science, that circumstances may be so varied, by the modes of charging the furnace, as to endanger an erroneous result: but, if proper attention be paid, the assayer will soon understand the trim of his furnace so thoroughly as to be sure of always obtaining such an accurate indication of the heat as cannot

6 fail

fail to be of eſſential ſervice to him. This fact I can atteſt from experience.

If abſolute preciſion be wanted, it may be obtained by employing three or more pyrometers, diſtributed at regular diſtances round the furnace, inſtead of uſing only one. The mean of the whole will be the true degree of heat in the furnace.

VII. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth.* *By* M. De Saussure.

[Continued from page 190.]

CHAP. XVIII.

A. *Obſervations to be made on Volcanoes at the Time of an Eruption.*

1. THE form, dimenſions, and elevation of the crater.

2. The colour, elevation, and other ſenſible qualities of the flames and the ſmoke.

3. Phenomena which preceded the eruption, ſubterranean noiſe, earthquakes, extraordinary movements of the ſea.

4. Phenomena which accompany the eruption; as thunder, lightning, poſitive or negative electricity, ſubterranean noiſe, earthquakes: ſcoriæ, aſhes, and ſtones thrown up; to what height and diſtance.

5. Smell of the ſmoke. In general it indicates the ſulphureous acid; but it may indicate alſo bitumen and coal.

6. Nature of the gaſes which eſcape during the eruption.

7. Velocity of the lava. Its degree of fluidity compared with the inclination of the ground over which it flows.

8. To meaſure, if poſſible, the degree of its heat when it iſſues from the volcano.

9. Whether the lava appears to be in a ſtate of combuſtion, or only incandeſcence.

10. Whether it does not cool more ſlowly, and according to other laws, than that of the bodies heated or melted in our furnaces.

10. A. Can it be ſuppoſed that the matter thrown up by volcanoes was not inflamed, or even in a ſtate of incandeſcence, in the bowels of the earth; and that it is only the contact of the air which gives it theſe qualities?

11. Whether the ſudden cooling of lava in the air or in water divides it into priſmatic columns, ſuch as thoſe of baſaltes.

12. Whether it be true that ſcoria newly thrown up, and ſuddenly cooled by its rapid paſſage through the air, ſeems covered with a bituminous varniſh.

13. And, in general, whether the mountain throws up bituminous matter or any thing that reſembles the reſiduum of the combuſtion of coal, or whether it rather throws up pyrites or the reſiduum of their decompoſition.

14. To aſcertain by obſervations, and even by experiments, whether it may not be poſſible that pyrites or other ferruginous matters decompoſed by water, undergo a fermentation, which, acting on grand maſſes, may diſengage a ſufficient heat to produce the effects of a volcano.

15. Or whether, as M. Romme thinks, the fire of volcanoes is kept up by matters accumulated by rivers and currents of the ſea.

16. To ſearch for means of aſcertaining the depth of the focus of the volcano.

17. To examine whether, at the moment when an eruption begins to take place, there is any remarkable change in the tides, currents, ſprings, and the neareſt ſpiracles and volcanoes.

18. Muddy eruptions: their height, bulk, nature of the water they contain; whether it be ſaline: nature of the earth and ſtones thrown up; whether it contains ſea ſhells, of what kinds, and in what ſtate. Watery eruptions: the ſame re-

ſearches: whether they hold in ſolution earths not uſually ſoluble in water *.

B. *Obſervations to be made at all Times on Volcanoes decidedly ſuch.*

19. Nature of the countries and mountains between which they are found.

20. Hiſtory of the volcano: its form, height, and extent in the moſt ancient times; its ſucceſſive changes down to the preſent moment; its lateral mouths, and the epochs of their formation.

21. Chronology and enumeration of its different eruptions; deſcription of them, and their moſt remarkable characters.

22. To deſcend, if poſſible, into the craters of extinguiſhed volcanoes; to meaſure their depth; deſcribe their form, the nature of their ſides, their ſtrata, and the concretions adhering to them, ſuch as ſulphur, ſalt, &c.

22. A. To obſerve the *fumaroles*, or jets of ſmoke, often acid, which ariſe; their temperature, their nature, and their effects on the lava with which they come in contact.

23. To examine the fiſſures; whether they contain metallic or ſtoney cryſtalliſations, which may be conſidered as ſublimed, and formed by the cryſtalliſation of ſubſtances reduced to the ſtate of ſmoke or vapour.

24. The nature of the ſtreams of cooled lava; their extent and thickneſs.

25. Whether it be true that, in general, they are porous both at the upper and lower ſurfaces of the ſtrata, and compact in the interior part.

26. To ſtudy the nature of the different currents placed above each other, in order to aſcertain the difference that may have taken place in the focus of the volcano, and even in the ſource of its lava.

* To obſerve thoſe excavations from which conſiderable currents of air iſſue either periodically or conſtantly. C.

27. To examine, in general, in the lava, the nature of the earth and ſtones of which it has been formed.

27. A. To ſtudy the origin of the cryſtals found incloſed in the lava, as the white garnets or leucites in that of Veſuvius, in order to aſcertain whether theſe cryſtals have been formed in the lava ſince the time of its fuſion, or whether they pre-exiſted in the ſtones from which the lava was produced.

28. The nature and progreſs of the decompoſition of the different kinds of lava, either by volcanic acids or meteors.

28. A. Whether there are any which have actually been in fuſion, and yet have preſerved all the external characters which the ſtone had before it was ſubjected to the action of the ſubterranean fires.

29. The origin of volcanic aſhes, pozzolanas, tarras, tufas, &c.

30. The origin of pumice-ſtones: whether they are granites or feld-ſpars, aſbeſtos, phrenites, deodalites, or potter's clay more or leſs ferruginous, or, laſtly, the remains of the decompoſition of pit-coal.

30. A. Whether, as M. de Fichtel believes, the action of the fire of volcanoes may augment the fuſibility of feld-ſpar, and change it, in the ſame manner as quartz, into real zeolite.

31. Nature of the obſidians or volcanic glaſs: whether they be really glaſs, and the reſults of a complete fuſion; or whether they are not rather ſtones of a vitreous appearance, and which have not been expoſed to the action of a heat ſufficiently ſtrong to fuſe them.

32. Whether there exiſt ancient kinds of lava, which, as related of thoſe of Iſchia, are ſuſceptible of being heated by the moiſture of rain and fogs, which would ſupport the conjecture of No. 14.

C. *Obſervations to be made on Hills and Mountains which are doubted to have been really Volcanoes.*

33. The form, elevation, and other dimenſions of the hill

or

or mountain, the volcanic origin of which may appear doubtful.

34. Situation of its ſtrata. To aſcend to the ſummit of thoſe which are inclined; to examine whether they have not a crater, or veſtiges of one.

35. To obſerve, above all, whether, in departing from the moſt elevated point, there are found ſtrata diverging in all parts, and proceeding from that point as a centre.

36. To ſtudy the characters of the ſtones which have been expoſed to the action of the fire, in order to diſtinguiſh them from other porous ſtones, ſuch as glandulous ſtones or amygdaloides.

37. When theſe characters are diſcovered, to examine whether, in the neighbourhood of the doubtful mountain, there are found ſcattered ſtones which exhibit the ſame characters, and which ſeem to have proceeded from that mountain.

38. To obſerve whether there are found, in the neighbourhood of the doubtful mountain, any veſtige of the remains of heat concealed in the boſom of the earth, as of thermal, or even acidulous waters. It is well known that theſe ſigns are equivocal, but their combination with others may throw ſome weight into the ſcale.

38. A. Whether there exiſt certain proofs of alternate depoſits of lava or other volcanic productions, and of matters accumulated or depoſited by the ſea.

39. Among the ſtones changed by the fire, to diſcover thoſe which may be conſidered as having been ſubjected to the action of one ſtratum of coal in deflagration, and which the celebrated Werner calls *pſeudo-volcanic*, and to diſtinguiſh them from thoſe which have been fuſed in a real volcano.

40. Baſaltes: their forms in columns, in beds, round maſſes; their connections, the relation which the baſaltes of theſe different forms obſerve with each other.

41. The nature of theſe baſaltes: that of their texture, of the points which they contain, of the pores and empty

or full cells that may be obſerved in them; of their different accidents and decompoſition.

41. A. The phenomena they exhibit in the fire, either expoſed to, or ſheltered from the action of the air. But before any arguments are drawn from theſe experiments, it will be neceſſary to reſolve the queſtion, Whether it be true that a ſtone may have been melted by ſubterranean fire, and yet none of its characters exhibit thoſe indications of fuſion which the fire of our furnaces would have given to the ſame ſtone.

42. Their connection, if there be any, with lava, fully aſcertained as ſuch: if it be true, for example, as M. Faujas affirms, that currents of lava are ſeen terminated by columns of baſaltes.

43. The nature of the baſes on which the baſaltes reſts: whether, as M. Werner ſays, any is found reſting on wacke or hornſtone, of an earthy and compact fracture, which itſelf repoſes on ſand or freeſtone.

44. Whether at other times baſaltes is ſeen to repoſe on beds of coal (*bouille*) which preſent no indications of combuſtion.

45. In a word, to examine whether the ſoil which bears them, or the ſides of the veins in which they are contained, preſent indications of the action of fire, or at leaſt of having been expoſed to the contact of an incandeſcent maſs; or, on the contrary, whether there appear indications of depoſits of a ſubſtance which had been in a ſtate of aqueous fluidity.

46. Whether there are in the baſaltes veſtiges of organiſed marine bodies or others; and in what ſtate theſe veſtiges are found.

47. Whether there are obſerved, as M. Faujas ſays, baſaltes which ſeems to have formed a paſſage for itſelf from top to bottom through maſſes of granite.

48. In doubtful caſes of this kind it would be neceſſary, were it poſſible to be at the expence, to puſh a gallery under a rock of baſaltes, to examine whether the columns deſcend

below

below the soil which seems to carry them; and if they are found below the soil, to sink a vertical well to ascertain the truth of the systems which suppose them to have been raised from the interior parts of the earth through the upper strata.

[To be continued.]

VIII. *Observations on the different Inducements to the Eating of Human Flesh. By* J. DE LOUREIRO *.

THE first inducement which can lead men to this excess is extreme hunger; but however pardonable it may be under such circumstances, if the flesh used be that of dead bodies, it is highly detestable on account of the consequences. During a dreadful famine in India, which destroyed more than a hundred thousand persons, when the roads and streets were covered with dead bodies, because people had not sufficient strength to inter them, I saw several have the resolution to preserve their lives by this disgusting food; but some of them, though not many, found it so delicious that when the famine was at an end they retained such an irresistible propensity to human flesh that they lay in wait for the living in order to devour them. Besides others, there was a mountaineer who concealed himself in a forest near the highway, where he used to cast a rope, with a noose, over the heads of the passengers, whom he afterwards cut to pieces to gratify his unnatural appetite. He had killed many persons in this manner, but he was at length caught and executed. At the same time, and owing to the same cause, a woman used to go out for the express purpose of carrying away children who had strayed from their homes. She stopped up their nose

* The author of this paper is an eminent Portuguese naturalist. A copy of it was given by the author from his own manuscript, never published, to Dr. G. H. Langsdorf, physician to Prince Christian of Waldeck at Lisbon, on the 5th of January 1798, who translated it into German, and sent it to Professor Voigt of Jena. See his *Magazin für den neuesten zustand der Naturkunde*, Vol. I. part 3.

and

and mouth with clay that they might not call out for assistance, and by these means suffocated them. She confessed the fact on being taken, and some salted human flesh was found in her habitation. My servant having entered it, observed a girl of four or five years of age who had been suffocated in the above manner, and who was lying wrapped up, half dead, in a mat. By employing proper means she was however restored to life.

The reason of the second inducement to anthropophagy will now be readily comprehended. We read in different works, both ancient and modern, that many nations, in various parts of the world, have killed men, not on account of famine, but of the delicious taste of human flesh, which they not only fed upon but publicly sold.

The third inducement, that people eat their deceased relations by way of shewing them honour, seems to be as romantic as it is repugnant to nature; yet there are many authors, from Herodotus, the father of history, down to modern times, who assert that this practice has prevailed among various nations.

A fourth incitement to eat human flesh is hatred and revenge. There is a law in Cochinchina, that all rebels, when convicted of their crime, shall be executed, and that their flesh shall be devoured by the king's loyal subjects, and, in particular, by those who are nearest his person. At the time I resided in that country several executions of this kind took place. The men were beheaded, but the women were stabbed. After the execution the soldiers who guarded the palace flocked around the bodies, and each cutting off, with a pocket knife, a small piece, dipped it in the juice of an unripe lemon, and in that manner swallowed it. But as the size of the morsel is not determined by the law, and as most of the people have an aversion to such food, many suffer the bit of flesh to drop through their fingers and swallow only the lemon.

At the time when the Cochinese were at war against the

Mois,

Mois, a people who inhabit the mountains to the weſt, and who often make incurſions into their territories, the Cochineſe general marched with an army towards the mountains; but as he was not able to get at the enemy, on account of their inacceſſible ſituation, he ordered two priſoners he had taken to be put to death, and their fleſh to be devoured by his ſoldiers.

In the year 1777, being on board an Engliſh ſhip of war in Turon harbour, in order to return from Cochin-china to Europe, a party arrived there who had joined a powerful rebel named *Nhac*. This leader and his party had taken ſome of the king's confidential friends, and one in particular who had formerly done him a great deal of injury. The latter they put to death; and in order to gratify their revenge, they tore out his liver and ate it. The Cochin-chineſe, in general, when violently incenſed againſt any one, are accuſtomed to expreſs a wiſh that they may be able to devour his liver or his fleſh.

IX. *Deſcription of an improved Diſcharging Electrometer. Read before the Royal Society of Copenhagen. By* A. W. Von Hauch, *Marſhal of the Court, &c. to his Daniſh Majeſty* *.

No branch of natural philoſophy can boaſt of having attracted ſo much attention as the doctrine of electricity; and indeed there are few which ſeem more worthy of inveſtigation. When we conſider the diſtinguiſhed part which electricity apparently performs in the grand operations of nature; the aſtoniſhing, and, on the firſt view, ſo inexplicable effects produced by this power of nature ſo different from thoſe of any other, and its ſecret and concealed mode of action, which the moſt acute obſervers have not hitherto been able to penetrate, it will not ſeem ſurpriſing that both

* From the *Tranſactions of the Royal Society of Copenhagen.*

the

the learned and the unlearned ſhould, with unabated zeal, have employed their attention on this phenomenon, as important to ſpeculative philoſophy as it is by its influence in ſociety. Without this inceſſant attention our knowledge would not have made ſuch rapid progreſs as it has done in the laſt forty years; and there might have been little difference between Otto von Guerick's balls of ſulphur, or Hauſen's glaſs globes, which were ſeventy years later, and the electric machine now in the Teylerian Muſeum at Haerlem. The former were ſcarcely ſufficient to attract the lighteſt bodies, whereas the latter approaches near to nature in its ſtrength, in its awful and wonderful effects; and ſeems to favour the poſſibility of the idea, that there are natural powers capable of impelling heavy bodies with prodigious force; and which, conducted by the hand of man, may, ſome centuries hence, baniſh the uſe of gunpowder, as the latter, a few centuries ago, baniſhed bows and arrows.

Franklin conveyed electricity from the atmoſphere, loaded a battery with it, and directed its mighty power with the ſame eaſe as that weak power excited by an electric machine. On account of the above-mentioned poſſibility of exhibiting the electric power in a certain degree and of a certain ſtrength, it was found more and more neceſſary to have inſtruments proper for aſcertaining theſe, and by which it might be determined with preciſion when and how a required effect could be produced.

Though theſe inſtruments have undergone many variations and improvements, and though there is an eſſential difference between Stephen Gray's or Du Fay's threads and the electrometers of Achard and Brooks *, they are all to be conſidered rather as announcers of electricity than as accurate gauges or meaſures, as they are all incapable of ſhewing its intenſity. Another inſtrument, hitherto equally imper-

* A deſcription of theſe Electrometers may be ſeen in Adams's and Cavallo's Treatiſes of Electricity, and in other works of the like kind. EDIT.

fect,

fect, though no leſs important in electric experiments, is a diſcharging electrometer; for, as it is believed that the laws of electricity can be defined with mathematical certainty *, it muſt be of importance to be able to employ, with the ſame certainty, the electric power which has been excited; and every inſtrument tending to promote this object, though ſtill imperfect, muſt be of ſome utility, and be not unacceptable to thoſe fond of electrical experiments. All the diſcharging electrometers hitherto known, perform their effect either by ſpontaneouſly diſcharging, as that of Lane, or as Henley's general diſcharger, &c. and in this caſe are affected by the greater or leſs conducting property of the air, which muſt neceſſarily be changed on each change of the atmoſphere, and therefore muſt render the inſtrument very imperfect and incorrect; or the effect is produced by introducing a conducting body between two electric atmoſpheres, and by theſe means uniting them. But as this muſt depend on the greater or leſs dexterity of the perſon who performs the experiment to determine the proper moment for diſcharging, and as another electrometer is at the ſame time neceſſary, this method of diſcharging is as uncertain as the firſt.

I have endeavoured, therefore, to conſtruct an inſtrument to ſupply this deficiency; and I hope it will not be found unworthy of attention. It is an electrometer which, though founded on the ſame principles as that of Brooks, that is, on comparing the effect of the repulſive power of electricity between two bodies of a given ſize with the known weight requiſite to produce that effect, has, in my opinion, ſome improvements which are wanting in the other; for the ſtate of the barometer has no influence upon this electrometer, as it has on that of Brooks; nor does friction, which is far from being unimportant, here take place. But as this in-

* See Lord Stanhope's *Principles of Electricity*, 3d, 4th, and 5th parts; and Coulomb's deſcription of an inſtrument by which it is proved that the effect of the electric matter is in the inverſe ratio of the ſquare of the diſtance.

ſtrument

ſtrument is intended to be uſed as a diſcharging electrometer, and muſt be examined as ſuch, no compariſon can properly be made between it and any of the other electrometers hitherto employed.

Plate VI contains a repreſentation of the electrometer, and the different parts of which it conſiſts. OP is a board of dry mahogany, twelve inches in length and four in breadth, which ſerves as a ſtand for the inſtrument. In this board are faſtened two maſſy glaſs pillars, M and N, which ſupport the two braſs capes or rings GG, with the two forks of tempered ſteel KK ſcrewed into them. The two rings GG are well covered with varniſh.

In the ring G is faſtened a braſs rod, which terminates in a ball E of the ſame metal, and an inch in diameter. The length of the rod and ball together is four inches and a half.

A very delicate beam, AB, the arms of which are of unequal length, moves on a ſharp triangular axis (a knife edge) of well tempered ſteel on the fork K of the pillar M. It is ſeventeen inches in length, and ſo conſtructed that the ſhort arm forms a third and the long one two-thirds of the whole beam. The ſhort arm of braſs furniſhed with the ball B, exactly of the ſame ſize as the ball E, is divided into forty-five parts equivalent to grains. The long arm A is of glaſs covered with copal varniſh, and ends in an ivory ball A, into which is fitted an ivory hook R, deſtined to ſupport the ivory ſcale H. In order to render the inſulation more complete, this ſcale is ſuſpended by three hairs.

A very delicate beam, CD, eleven inches in length, moves on an axis, like the former, on the pillar N, though not here ſhewn. This beam is proportioned in the ſame manner, one arm being a third and the other two-thirds of the whole length. The long arm of braſs is furniſhed at the end with a ball D, and divided into thirty parts correſponding to grains. The ſhort arm of glaſs terminates in a long roundiſh plate C, covered with copal varniſh. The ſteel

forks

forks are ſhewn by the ſections of the two braſs caps FF, as are alſo the two knife edges LL. By theſe caps the eſcape of the electric matter is partly prevented.

A braſs ring Q, capable of being moved along the ſhort arm of the upper beam AB, ſhews, by means of marks determined by trial and cut out on the beam, the number of grains which muſt be placed in the ſmall ſcale to reſtore the equilibrium of the beam at each diſtance of the ring Q from the point of ſuſpenſion.

On the long arm CD of the lower beam there is alſo a moveable ring S, which, like the ring Q, ſhews in grains, by its diſtance from the point of ſuſpenſion, the power requiſite to overcome the preponderance of LD in regard to LC.

The power neceſſary for this purpoſe will be found if the ſhell H, which weighs exactly fourteen grains, be ſuffered to ſink down on the glaſs plate C, and the ring S be puſhed forwards till both the arms of the beam are in equilibrium. The part of the beam on which the ring S has moved is divided into fourteen parts, ſo that *o* marks the place where the ring S muſt ſtand when the beam, in its free ſtate, is in equilibrium; and 14 ſtands at the place where the ring S again reſtores a perfect equilibrium when the ſhell H is laid on the glaſs plate C. Each of theſe parts, which are divided into quarters, indicates a grain. The lower diviſions of the ſcale will be found with more accuracy if quarters of a grain be put, in ſucceſſion, into the ſhell H (after it has been laid on the plate C), and the ring S be moved between each quarter of a grain until the perfect equilibrium be reſtored. This place on the beam is then to be marked, and you may continue in this manner until the 30th part of a grain be given. Both ſcales, for the ſake of diſtinctneſs, are divided only ſo low as quarters of a grain; though the inſtrument is ſo delicate, and muſt abſolutely be ſo, that 1-20th of a grain is ſufficient to deſtroy the equilibrium.

The two glaſs pillars M and N, together with the ſteel forks

forks affixed to them, are so fitted into the stand that both the beams lie parallel to each other as well as to the rod GE. In this position of the beams AB, the balls B and E are just in contact. The smallest glass pillar N is of such a height that the ball of the beam CD stands at the distance of exactly four lines from the ring G, and cannot move without touching the latter. The small shell H is suspended in such a manner that there is a distance of exactly two lines between it and the shell C. In each of the brass rings GG is a small hole, that the instrument may be connected with the two sides of an electric jar. I is a brass wire, with a hollow bit of ivory *a* destined to support the beam CD, which is necessarily preponderant at D, in order to prevent oscillation between the discharges to be examined by the instrument.

It may be readily comprehended that, when the beam AB has moved, A must pass over twice the space that B does; and that, in the beam CD, the case is the same in regard to C and D. If AB therefore be connected with the external side, and CD with the internal side of a battery, but in such a manner that the instrument is at a sufficient distance beyond the electric atmosphere; and if the battery be charged, the repulsive effect of the electric power will oblige the ball B to separate from the ball E; the shell H must therefore naturally sink down with double velocity, so that when the ball B rises a line, the shell H must sink two: when it reaches this depth it will touch the shell C, and the latter, by the power excited in it, will be obliged to sink, by which D must naturally again ascend in a double proportion to the sinking of C; so that when C has fallen two lines, D must have ascended four, and D that moment touches the ring by which the two sides of the battery are connected with each other, and discharges the battery.

But, as the attractive electric power between unlike atmospheres, under like circumstances, is at least as strong as its repulsive power between like atmospheres, it would thence follow that the electric power, instead of repelling the ball B from

from the ball E would rather attract D, and, by its contact with G, promote the discharging; by which the instrument would fail of its object, and be subjected to the temperature of the atmosphere like all other electrometers; and besides this, the electric power could no longer be determined by weight. To obviate this inconvenience, the instrument, in all electrical experiments, must be applied in such a manner that the power with which the ball D is attracted by AB may exceed in strength the power required to repel the ball B from the ball E. For this purpose the ring S must always be removed two divisions farther on CD, towards D, than the ring Q is shifted on AB towards B. If, for example, an electric force were required equal to eight grains, according to this electrometer, the ring Q must be removed to the place where 8 stands, and the ring S to the place marked 10. The repulsive power will then naturally repel the balls B and E before G is in a condition to attract the ball D, as a power of two grains would be necessary for this purpose, besides that of the eight already in action. The shell H, with its weight of fourteen grains, will easily overcome the preponderance of LD over LC, as it amounts only to ten grains, and therefore nothing exists that can impede the discharging.

When the ring S, according to the required power, is removed so far towards D that the shell H is not able by its weight to destroy the preponderance of LD in regard to LC, the active power of the shell H must be so far increased by the addition of weights that it can act, with a preponderance of four grains, on the plate C. If, for example, an electric power of fourteen grains be required, the ring S must be removed to 16, by which LD rests upon *a*, with a preponderance of sixteen grains in regard to LC. Now to make H act on the plate C with a preponderance of four grains, it must be increased to twenty grains, that is, six grains weight more must be added, as it weighs only fourteen; which six grains are again laid upon LB; and therefore the ring Q is shifted to 20, as the

ſtrength of the repulſive power is pointed out by fourteen grains.

If an electric power of twenty-five grains be required, the ring S muſt be removed to 27, and the weight of ſeventeen grains be put into the ſhell H in order to produce a preponderance of four grains in regard to S. Theſe ſeventeen grains are added to the required power of twenty-five grains, and the ring Q is puſhed to 42, &c. In this manner the repulſive power always acts before the attractive power can.

It may be readily perceived that the faults and inconveniences common to all the electrometers hitherto employed, and which have been already mentioned, cannot take place here; becauſe the diſcharging is performed by immediate connection between the poſitive and negative electricity in the inſtrument itſelf, without any external means being employed.

One of the moſt eſſential advantages of this inſtrument is, the certainty with which the ſame reſult may be expected when the experiment is repeated. For the ſame degree of electric power, whatever be the temperature of the atmoſphere, will always be neceſſary to commence the ſeparation of the two balls B and E from each other, the quantity of coated glaſs and the diſtance of the ring Q from the axis L being the ſame.

Another no leſs important advantage of this inſtrument is, that in an experiment where the ſame electric power, often repeated, is neceſſary to aſcertain the reſult with accuracy; ſuch, for example, as the charging a battery through acids, water, &c.; the ſame degree of precaution is not neceſſary as is indiſpenſibly ſo in any other electrometer, as the perſon who puts the machine in motion has nothing to do but to count how often the electrometer diſcharges itſelf; and the inſtrument may be incloſed in a glaſs caſe, or prevented in any other manner from external contact, or any other circumſtances which might render the experiment uncertain.

I flatter

I flatter myſelf that the ſimplicity of the conſtruction of this inſtrument, the facility with which it may be made at a very ſmall expence, and the certainty that two inſtruments, prepared according to the ſame ſcale, with a like quantity of coated glaſs, muſt exactly correſpond with each other; but, above all, that the certainty and accuracy by which experiments may be made with it, and by theſe means be accurately deſcribed, are advantages which will not be found united in any of the electrometers hitherto invented.

X. *Obſervations on the Tones produced by an Organ-pipe in different Kinds of Gas.* By C. F. F. Chladni*.

AIR, it is well known, is the moſt common conductor of ſound; but it can become a ſonorous body alſo. The latter is the caſe in regard to a pipe, as the pipe itſelf does not emit ſound, but the column of air included in it, and which, being ſeparated from the reſt of the atmoſphere, is obliged, by blowing, to vibrate in ſuch a manner that it contracts and expands longitudinally in various ways; and theſe vibrations are then conducted to a diſtance by the ſurrounding air. It is not neceſſary that I ſhould here farther explain the different kinds of vibration of which the air in a pipe is ſuſceptible. Thoſe who are deſirous of information on this ſubject may conſult Daniel Bernoulli's papers in the Memoirs of the Academy of Paris for 1762; thoſe of Lambert, in the Memoirs of the Academy of Berlin for 1775; and of Euler, in the Sixteenth Volume of the New Tranſactions of the Imperial Academy of Peterſburgh.

The conducting of ſound through the air, and the vibrations of air in a pipe, depend on the ſame laws. This will readily appear from the following obſervation, beſides others, that the velocity of the vibrations, under like circumſtances,

* From *Voigt's Magazin für den neueſten zuſtand der Naturkunde*, Vol. I. part 3.

depends merely on the length of the pipe, and not on its diameter; ſo that the velocity is not changed when the pipe is indefinitely enlarged, or, what is the ſame thing, when it is totally removed, ſo as to afford free acceſs to the air on all ſides. Sound therefore is diffuſed through a certain ſpace of air, in the ſame time in which a column of air incloſed in a pipe makes one vibration; a propoſition which has been proved in the before-mentioned papers of Euler, Bernoulli, and Lambert, and alſo by Count Giordano Riccati in his Treatiſe on Elaſtic Fibres or Strings, and which is confirmed by experience. Hence it follows, that the number of the vibrations made by the air in a pipe may be found, if the real velocity with which ſound is conducted through the air be divided by the length of the column of air contained in the pipe.

The labours undertaken by Newton, Euler, Daniel Bernoulli, Lambert, Giordano Riccati, and others, to determine, from general mechanical principles, the velocity with which ſound is conducted, have given no other reſults than thoſe taught by experience. By all theſe theoretic reſearches the ſpace through which ſound paſſes in the air, or, in general, in any expanſible fluid ſubſtance, was found to be $= \sqrt{\frac{2ga}{b}}$; where g is the ſpace through which a heavy body falls in a ſecond, or in any given time; a the elaſticity of the expanſible fluid, which is aſſumed equal to the preſſure it ſuſtains from the atmoſphere; and b the denſity of the expanſible fluid: a may be alſo the height of the barometer, if the denſity of the mercury be conſidered as 1. Theory gives, therefore, about 900 Pariſian feet as the diſtance to which ſound is tranſmitted through the air in the courſe of a ſecond; whereas this ſpace has been found, by experience, to be equal to about 1038. No one has ever yet aſſigned a ſufficient reaſon for this difference. The moſt common conjecture is, that it muſt be owing to a mixture of various foreign particles; but this, by thoſe acquainted with

with the nature of atmoſpheric air and the different kinds of gaſes, as aſcertained by chemical experiments, can hardly be admitted, and is contradicted by this circumſtance: that, according to every obſervation, the ſtate of the air, whether moiſt or dry, cloudy or rainy, does not alter, or at leaſt in a ſenſible manner, the velocity with which ſound is conducted. Various other conjectures ſeem to be equally inconſiſtent with nature. From the preſent experiments it follows, in my opinion, that the velocity of the vibrations of an expanſible fluid ſubſtance cannot be determined by the mechanical principles hitherto admitted alone; but that it depends, beſides theſe, upon other properties.

Were the before-mentioned data ſufficient to determine the vibrations of an expanſible fluid, the tone which a pipe can emit, both in the air and in different kinds of gaſes, under like circumſtances, would be inverſely as the ſquare root of the ſpecific gravity of the expanſible fluids. The reſult given by the preſent experiments is, however, different. As I was not furniſhed with the apparatus proper for the purpoſe, I requeſted, during my reſidence at Vienna, profeſſor Jacquin junior, who has a great zeal for the progreſs of ſcience, to undertake the experiments; and he was ſo good as to comply with my wiſhes.

The apparatus conſiſted of an open tin organ-pipe, in which the length of the vibrating column of air from the aperture where the inflated air iſſues to the end was about ſix inches, having its upper end inſerted in the neck of a bell-glaſs, that could be cloſely ſhut by means of a cock. On immerſing the bell in water, the pipe was at the ſame time filled with it, to guard againſt all mixture of atmoſpheric air. A bladder, furniſhed alſo with a cock, was ſcrewed upon the neck of the bell, after having been compreſſed as much as poſſible, and emptied of air by applying the mouth to it. The bell and the bladder were then filled with ſuch a quantity of the air to be examined, that the water, in which the bell was immerſed, ſtood at an equal

height both in the inſide and outſide; and the preſſure ſuſtained by the bell was equal, therefore, to the preſſure of the atmoſphere. The pipe was blown by compreſſing the bladder; but the greateſt caution was neceſſary to prevent the pipe from emitting, inſtead of its natural tone, any of its higher tones, which in an open pipe, as is well known, are as the natural ſeries of the numbers, that is, in arithmetical progreſſion. A weak and uniform preſſure was therefore neceſſary, but which could be repeated at pleaſure; becauſe, when the preſſure was omitted, the ſuperfluous gas returned back into the bladder. The temperature, which certainly contributes in ſome degree to vary the tone of a wind inſtrument, in regard to all the different kinds of gas, was always the ſame; that is, the degree which is uſual on a ſomewhat cool morning in ſpring. To enable me to judge with more accuracy of the tone, I had tuned two ſtrings to an uniſon of that tone produced in common air: the experiments were made with the utmoſt accuracy, ſo that I have reaſon to think there was no room left for the ſmalleſt deception.

The bell and the pipe being firſt filled with common air, the tone was exactly the ſame as that of a pipe blown when it is perfectly free; but much weaker, as muſt have been expected, becauſe the vibrations of the air incloſed in the bell were propagated, and could be communicated to the ſurrounding atmoſphere only through the ſides of the bell and through the water. But though the ſound, for the ſame reaſon, was ſomewhat weak in the other experiments, they could, however, be heard very diſtinctly.

In oxygen gas from manganeſe the ſound was half a tone or nearly a whole tone lower than in common air. This nearly agrees with theory; according to which the difference muſt amount to almoſt half a tone, if the gravity of atmoſpheric air be to that of oxygen gas as 1 to 1·103, and the tone inverſely as the ſquare root of the gravity.

The moſt ſtriking deviation from theory was exhibited by azotic gas. It might have been expected that the ſound of

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it would have been a little higher than that of common air, becauſe it is ſomewhat lighter, and becauſe its gravity is to that of atmoſpheric air as 0·985 to 1; but it was half a tone lower. Three kinds of azotic gas were tried; one produced bymeans of liver of ſulphur, another by a mixture of iron and ſulphur, and the third from common air by means of nitrous gas.

In all the three a taper was extinguiſhed in a moment, and they all gave the ſame tone. Should it be here ſuſpected that the azotic gas diſengaged from atmoſpheric air by ſulphur and iron, might have had a mixture of hydrogen gas, the tone in that caſe muſt have been raiſed rather than lowered by the latter on account of its lightneſs. We may therefore conſider it as certain, that the vibrations of azotic gas, let it be prepared in whatever manner it may, are much ſlower than the vibrations of atmoſpheric air; and that the difference amounts to about half a tone. It is remarkable that azotic gas in particular ſhould exhibit, in regard to its vibrations, ſuch a variation from the common theory, as, according to late experiments, it differs ſo much from other kinds of gaſes in regard to its expanſibility at different degrees of heat. It would be well worth the trouble to repeat theſe experiments, reſpecting the vibrations of azotic gas, at different high and low degrees of temperature. It ought alſo to be examined with more accuracy, whether Marriot's law, that at the ſame temperature the denſity of an expanſible fluid increaſes and decreaſes in proportion to its preſſure, may not admit of ſome exception in regard to azotic gas; as this inquiry would, in all probability, enable us to explain the variation of its vibrations from the common theory.

A very remarkable phenomenon was exhibited by a mixture of azotic and oxygen gas. It might have been ſuppoſed, that azotic gas, being a lighter ſubſtance, would have occaſioned a higher tone than atmoſpheric air; and oxygen

gas, as a heavier ſubſtance, a lower tone; and that a mixture of theſe two would have given a mean tone between both. Experience, however, ſhews that each of theſe two expanſible fluids, as I have already ſaid, gives a higher tone than atmoſpheric air; and that a mixture of them gives a tone higher than either of theſe can give alone, and perfectly ſimilar to the tone of atmoſpheric air. The quantity of oxygen gas mixed with the azotic gas might, according to appearance, be at firſt about a fourth; afterwards a third, or ſomewhat more; which however made no conſiderable variation in the tone. I am of opinion, therefore, that the unknown cauſe which occaſions a mixture of theſe two ſubſtances to vibrate quicker than each of them taken ſingly, may alſo occaſion ſound to be conducted with greater velocity than it ought, according to common theory, through atmoſpheric air, which has the ſame component parts as the above mixture. This greater velocity ſeems to imply rather a chemical than a merely mechanical mixture of theſe fluids. But this is contradicted, beſides other obſervations, by one in particular of that acute and diligent philoſopher Profeſſor Remigius Döttler of Vienna, who ſuffered common air to ſtand above a year untouched in a glaſs tube five feet in length and one and a half in diameter, which was well ſtopped both at top and bottom, and at the end of that time the component parts of the air were in ſome meaſure ſeparated from each other according to their ſpecific gravity; ſo that a lighted taper was extinguiſhed in the lighter azot found at the top, while another burnt in the heavy oxygen gas at the bottom with more ſtrength than in atmoſpheric air.

Hydrogen gas gave a far higher tone than atmoſpheric air; with that extricated by iron and the ſulphuric acid, the difference was about an octave; with that by zinc and the muriatic acid, it was nearly an octave and a whole tone; by that from the ſteam of water conducted through a tube of ignited iron, it was ſomewhat above an octave and a ſmall

third,

third. This difference, however, is not so great as might have been expected from so light a gas, the gravity of which is to that of common air, when the gas is perfectly pure, as 0·084 to 1. Had the tones, therefore, been inversely as the square roots of the gravity, the tone with hydrogen gas from iron and the sulphuric acid, allowing it to have been only six or seven times lighter than atmospheric air, must have been about an octave and a large third higher; and by the lighter hydrogen gas, about an octave and a small seventh higher. By mixing atmospheric air with hydrogen gas, the tone, as might readily be expected, was lowered; but it is to be remarked, that as long as these two fluids were not uniformly mixed by filling and compressing the bladder, a discordant noise only was heard, and not a distinct sound, as the vibrations could not be isochronous, which forms the only essential difference between a distinct sound and such a discordant noise. The same thing was observed in regard to the before-mentioned mixture of azotic and oxygen gas.

The tone of carbonic acid gas from chalk and the sulphuric acid was almost a large third lower than the tone of atmospheric air; which agrees pretty well with theory, since the gravity of these fluids is as 1·5 to 1.

Nitrous gas from nitrous acid and copper was not very favourable to sound; and it required a strong pressure of the bladder and a great deal of caution, because, instead of the wished-for low tone, one of the higher tones was produced. The lowest tone, obtained with considerable difficulty, was about half a tone lower than in atmospheric air; which agrees also pretty well with theory, since this gas is heavier, and the gravities are as 1·195 to 1: the tone was also almost like that in azotic gas, notwithstanding the considerable difference in the gravities of these two fluids.

As to the velocity with which the sound of another elastic body would be conducted through these gases, could a sufficient extent of them be procured to make the observation, it follows, from what has been said in the beginning of this paper,

paper, that with equal preſſure they would be in the ratio of the tones above mentioned.

The preſent experiments are very different from thoſe of Prieſtley and Perolle on ſound in different kinds of gaſes. The experiments of theſe two philoſophers had relation only to the intenſity with which the vibrations of another elaſtic body (of a bell ſtruck by a hammer) are conducted through theſe gaſes. Perolle contradicts Prieſtley's aſſertion, that the power of conducting is as the denſities; but to this rule Prieſtley himſelf makes an exception in regard to oxygen gas, which appears to be a ſtronger conductor: azotic gas was examined by neither of theſe philoſophers. In hydrogen gas they both found the conducting power very weak, which is no doubt owing to its little denſity. In oxygen gas they found the ſound ſomewhat ſtronger than in common air; in the nitrous gas Perolle found it alſo ſomewhat ſtronger. In carbonic acid gas Prieſtley found the ſound ſtronger; but Perolle, weaker, duller, and ſomewhat lower than in common air: which laſt circumſtance I conſider as agreeable to truth, becauſe the vibrations of a ſounding body muſt be more retarded the denſer the ſurrounding fluid is, or according to its greater preſſure on that body. For this reaſon the vibrations of a body vibrating in our atmoſpheric air muſt be a little ſlower than they would be in a vacuum; as experience teaches that the ſound of a bell becomes lower the more it is filled with water, or the deeper it is immerſed in that fluid; ſo that, when it is ſtruck at a conſiderable depth, it no longer emits a diſtinct ſound, but rather a kind of diſcordant noiſe.

XI. *Letter from* E. PEROLLE *of the Academy of Turin, formerly Profeſſor of Anatomy and the Practice of Medicine at Toulouſe, to* J. C. DE LA METHERIE, *on the Acouſtic Experiments of* CHLADNI *.

I READ in your Journal of Meſſidor, 6th year, and in the *Bulletin des Sciences*, publiſhed by the Philomatic Society of Pluvioſe the ſame year, a ſhort account of the experiments made by Chladni and Jacquin at Vienna, with a view to determine the ſonorous properties of various gaſeous ſubſtances. By cauſing a ſmall tin pipe, brought into contact with a cock in the neck of a bell glaſs, to be blown by gas contained in a bladder applied to the external aperture of the cock, theſe philoſophers obſerved, that the ſound was a ſemitone lower with azotic and oxygen gas than with atmoſpheric air; a third lower with carbonic acid gas; and nearly the ſame with nitrous gas: but, with oxygen gas, from nine to eleven tones higher than with the air that ſurrounds us. A mixture of azote and oxygen, in the ſame proportions as in atmoſpheric air, gave the ſame tone as the latter; but when the mixture of theſe gaſes was not uniform, the ſounds were totally diſcordant. The ſingularity of theſe reſults induced me to examine the experiments with attention.

Prieſtley †, ſeveral years ago, publiſhed ſome obſervations on the ſame ſubject; but he had made uſe of a metallic body rendered ſonorous by percuſſion, after he had fixed it in a glaſs jar, which he filled ſucceſſively with different kinds of gas. The aëriform ſubſtances which he employed for his experiments appeared to him to propagate ſounds in proportion to their denſity: he remarked, that in hydrogen gas the ſound ſeemed like that produced in a vacuum or air highly rarefied. Is it to be ſuppoſed that ſuch a philoſopher as Prieſtley would have failed to diſcover the alteration of tones produced in the va-

* From the *Journal de Phyſique*, an. 7.

† See *Obſervations and Experiments on different Branches of Philoſophy*, Part III. p. 355.—Prieſtley made no experiments with nitrous gas.

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rious aëriform ſubſtances? His ear would certainly have diſtinguiſhed the falling of a third in the carbonic acid and nitrous gaſes; and he muſt, no doubt, have been ſtruck with the prodigious riſe occaſioned by the hydrogen.

At the time Prieſtley made his experiments I was engaged in ſome of the ſame kind, the reſults of which were publiſhed in the Memoirs of the Academy of Sciences of Turin for the years 1786 and 1787. In my paper it may be ſeen that I ſucceſſively filled a bottle, and inverted it in a pneumato-chemical preparation of various aëriform ſubſtances; and in theſe atmoſpheres I rung a ſmall bell, and made a repeating-watch ſtrike. As the ſounds reached my ear, I paid attention to the variations they exhibited in regard to the tone, its intenſity, and the vibration. To aſſiſt my ear I made uſe of a violin. Some idea may be formed of the reſult of my labours, by caſting an eye over the firſt table of my memoir, of which the following is a copy:—

Nature of the Gaſes examined.	*Tone of the Sounds in different Airs.*	*Nature or Species of the Sound.*	*Diſtance at which they may be heard.*
1. Atmoſpheric air ſerving for a point of compariſon.			56 feet 6 inches.
2. Fixed air, drawn from chalk by diluted nitrous acid.	Alike, or a little lower than in the preceding experiment.	Conſiderably duller.	48 feet 5 inches.
3. Vital air extracted from red precipitate.	Seemed a little ſharper than in common air.	Clearer than in atmoſpheric air.	63 feet.
4. Nitrous air produced by a nitrous ſolution of tin.	Nearly like the former.	Ditto.	Ditto.
5. Inflammable air produced by the action of diluted vitriolic acid on ſteel filings.	Not very diſtinct: it ſeemed rather a weak noiſe than a proper tone.	Had no harmony, no ſtrength; and ſeemed to die away at	11 feet.

Chladni's experiments, therefore, ſeem to contradict thoſe made by Prieſtley and myſelf. To reconcile them, it will no doubt be ſaid that Chladni and Jacquin employed a wind-inſtrument, and that my experiments and thoſe of Prieſtley were made with metallic bodies rendered ſonorous by percuſſion. But whence does it happen that thoſe fluids, ſome of which lower the ſound of a pipe one-third, while another makes the ſound of the ſame pipe from nine to eleven tones higher, have not power to alter the tones of a metallic body in any ſenſible degree? I ſhall here offer a few remarks which ſeem to ariſe from theſe general obſervations.

In a mixture of oxygen and azote, in the ſame proportions as in the atmoſpheric air, ſound is the ſame, according to Chladni and Jacquin, as in the latter medium; but they add, if the mixture of theſe two gaſes is not complete, the ſound is quite diſcordant. What! do oxygen and azote afford each of them the ſame ſound? and does an incomplete mixture of them produce a diſcordant ſound? It will no doubt be replied, that azote and oxygen do not give the ſame tone as atmoſpheric air; but, in theatres, ball-rooms, concert-rooms, &c. where a great number of ſpectators are aſſembled, and where there is a ſufficient quantity of carbonic acid, which does not combine with the air of the atmoſphere, has it ever been obſerved that wind inſtruments were diſcordant? If an incomplete mixture of atmoſpheric air with gas, which lowers the ſound one third, does not render the ſounds diſcordant, how can we perſuade ourſelves that a mixture of two gaſes, which cauſe a falling of only half a tone, ſhould occaſion a ſound altogether diſcordant, merely becauſe the portions of the gaſes are completely mixed, while the admixture of ſome other particles is much leſs complete?

The above authors inform us alſo, that in hydrogen gas the ſound riſes nine or eleven tones. Here there can be no medium. Either the ſound produced in the hydrogen is ſharper by nine tones, and in that caſe the elevation ought

not to be carried to eleven; or the ſound is ſharper by eleven tones in the hydrogen than in atmoſpheric air, and then it is wrong to ſay that it riſes only nine tones.

This want of correctneſs and preciſion in determining the tone; this great latitude allowed to the hydrogen, of being able to raiſe the ſound nine or eleven tones; does it not prove an indeciſion, an uncertainty on the part of theſe philoſophers, little calculated to procure confidence to their experiments?

Let it not, however, be imagined, that I wiſh to conteſt the reality of their diſcoveries. Not having repeated the experiments of theſe authors, I can have no ſuch intention. I have only endeavoured to give an account of thoſe doubts which remained on my mind after I had taken the ſubject into conſideration, and to engage the philoſophers to remove the uncertainty by repeating the experiments.

One of theſe authors, Chladni, has made an obſervation which ſeems entirely his own. He obſerved, that when a plate of glaſs is agitated by means of a bow, if ſome duſt is ſtrewed over the glaſs, the former will appear to have arranged itſelf ſymmetrically, after the plate ceaſes to emit ſound. Under the like circumſtances the figures are always the ſame.

It is not at all ſurpriſing, that an elaſtic body, when put in motion by the ſame means, ſhould conſtantly experience effects of the ſame kind. The light body placed on the ſurface of the glaſs with which the experiment is made, only confirms what we were already taught by reaſon. But before it be concluded that theſe motions produce ſound, or tend to determine the tone, philoſophers are invited to read my Letter to De la Metherie *On the Total Vibrations of Sonorous Bodies*, publiſhed in the *Journal de Phyſique* for December 1785. This letter, the ſenſe of which is altered by ſome typographical errors *, contains facts a little too preciſe

* P. 424, at the end of the firſt line, add *adjutez*; ſame page, at the beginning of the 11th line, for *ſon* read *ton*; next line, for *anneau* read *arceau*.

perhaps,

perhaps, but which do not appear to me the leſs to merit the attention of the learned.

Philoſophers, in my opinion, will find ſome curious obſervations on this ſubject alſo in my *Inquiries into the Propagation of Sound in different Solid as well as Fluid Mediums*; which will ſoon appear.

XII. *On a Submarine Foreſt on the Eaſt Coaſt of England.* *By* Joseph Correa de Serra, LL.D. F.R.S. *and* A.S.*

In Geology, more perhaps than in any other branch of Natural Hiſtory, there exiſts a neceſſity of ſtrictly ſeparating the facts obſerved from the ideas which, in order to explain them, may occur to the mind of the obſerver. In the preſent ſtate of the ſcience, every well aſcertained fact increaſes our ſtill narrow ſtock of real knowledge; when on the contrary, the reaſonings we are enabled to make are at beſt but ingenious gueſſes, which too often bias and miſlead the judgement. I ſhall, therefore, endeavour in this paper to give, firſt, a mere deſcription of the object unmixed with any ſyſtematical ideas, and ſhall afterwards offer ſuch conjectures on its cauſes as ſeem to me to be fairly grounded on obſervation.

It was a common report in Lincolnſhire, that a large extent of iſlets of moor ſituated along its coaſt, and viſible only in the loweſt ebbs of the year, was chiefly compoſed of decayed trees. Theſe iſlets are marked in Mitchell's chart of that coaſt by the name of *clay huts*; and the village of Huttoft, oppoſite to which they principally lie, ſeems to have derived its name from them. In the month of September 1796 I went to Sutton, on the coaſt of Lincolnſhire, in the company of the Right Hon. the Preſident of the Royal Society, in order to examine their nature and extent. The

* From the Philoſophical Tranſactions, 1799.

19th of the month, being the first day after the equinoctial full moon, when the lowest ebbs were to be expected, we went in a boat about half past twelve at noon, and soon set foot upon one of the largest islands then appearing. Its exposed surface was about thirty yards long, and twenty-five wide, when the tide was at the lowest. A great number of smaller islets were visible around us, chiefly to the eastward and southward; and the fishermen, whose authority in this point is very competent, say, that similar moors are to be found along the whole coast, from Skegness to Grimsby, particularly off Addelthorpe and Mablethorpe. The channels dividing the islets were, at the time we saw them, wide, and of various depths; the islands themselves ranging generally from east to west in their largest dimensions.

We visited them again in the ebbs of the 20th and 21st; and though it did not generally ebb so far as we expected, we could notwithstanding ascertain that they consisted almost entirely of roots, trunks, branches and leaves of trees and shrubs, intermixed with some leaves of aquatic plants. The remains of some of these trees were still standing on their roots, while the trunks of the great part lay scattered on the ground in every possible direction. The barks of trees and roots appeared generally as fresh as when they were growing; in that of the branches particularly, of which a great quantity was found, even the thin silver membranes of the outer skin were discernible. The timber of all kinds, on the contrary, was decomposed, and soft in the greatest part of the trees: in some, however, it was firm, especially in the roots. The people of the country have often found among them very sound pieces of timber, fit to be employed for several economical purposes.

The sorts of wood which are still distinguishable, are, birch, fir, and oak. Other woods evidently exist in these islets, of some of which we found the leaves in the soil; but our present knowledge of the comparative anatomy of timber is not so far advanced as to afford us the means of pronouncing with

with confidence respecting their species. In general the trunks, branches, and roots of the decayed trees were considerably flattened; which is a phenomenon observed in the *surtarbrand*, or fossil wood of Iceland, and which Scheuchzer remarked also in the fossil wood found in the neighbourhood of the lake of Thun in Switzerland.

The soil to which the trees are affixed, and in which they grew, is a soft greasy *clay*; but for many inches above its surface, the soil is entirely composed of rotten leaves scarcely distinguishable to the eye, many of which may be separated by putting the soil in water, and dexterously and patiently using a spatula or blunt knife. By this method I obtained some perfect leaves of *Ilex aquifolium*, which are now in the herbarium of the Right Honourable Sir Joseph Banks; and some other leaves, which, though less perfect, seem to belong to some species of willow. In this stratum of rotten leaves we could also distinguish some roots of *Arundo phragmites*.

These islets, according to the most accurate information, extend at least twelve miles in length, and about a mile in breadth, opposite to Sutton shore. The water without them, towards the sea, generally deepens suddenly, so as to form a steep bank. The channels between the several islets, when the islets are dry, in the lowest ebbs of the year are from four to twelve feet deep: their bottoms are clay or sand, and their direction is generally from east to west.

A well, dug at Sutton by Joshua Searby, shows that a moor of the same nature is found under ground in that part of the country at the depth of sixteen feet, consequently very nearly on the same level with that which constitutes the islets. The disposition of the strata was found to be nearly as follows:——Clay, 16 feet—Moor, similar to that of the islets, 3 to 4 ditto—Soft moor, like the scowerings of a ditch bottom, mixed with shells and silt, 20 feet—Marly clay, 1 foot—Chalky rock, from 1 to 2 feet—Clay, 31 yards—Gravel and water; the water has a chalybeate taste.

In order to aſcertain the courſe of this ſubterraneous ſtratum of decayed vegetables, Sir Joſeph Banks directed a boring to be made in the fields belonging to the Royal Society in the pariſh of Mablethorpe. Moor of a ſimilar nature to that of Searby's well, and the iſlets, was found, very nearly on the ſame level, about four feet thick, and under a ſoft clay.

The whole appearance of the rotten vegetables, we obſerved, perfectly reſembles, according to the remark of Sir Joſeph Banks, the moor which, in Blankeney Fen and in other parts of the Eaſt Fen in Lincolnſhire, is thrown up in the making of banks; barks, like thoſe of the birch-tree, being there alſo abundantly found. The moor extends over all the Lincolnſhire fens, and has been traced as far as Peterborough, more than ſixty miles to the ſouth of Sutton. On the north ſide, the moory iſlets, according to the fiſhermen, extend as far as Grimſby, ſituated on the ſouth ſide the Humber: and it is a remarkable circumſtance, that in the large tracts of low land which lie on the ſouth banks of that river, a little above its mouth, there is a ſubterraneous ſtratum of decayed trees and ſhrubs exactly like thoſe we obſerved at Sutton; particularly at Axolme iſle, a tract of ten miles in length by five in breadth; and at Hatfield Chace, which comprehends one hundred and eighty thouſand acres. Dugdale * had long ago made this obſervation in the firſt of theſe places; and De la Pryme † in the ſecond. The roots are there, likewiſe, ſtanding in the places where they grew: the trunks lie proſtrate. The woods are of the ſame ſpecies as at Sutton. Roots of aquatic plants and reeds are likewiſe mixed with them; and they are covered by a ſtratum of ſome yards of ſoil, the thickneſs of which, though not aſcertained with exactneſs by the above-mentioned obſervers, we may eaſily conceive to correſpond with what covers the ſtratum of decayed wood at Sutton, by the

* Hiſtory of Embanking and Draining, chap. xxvii.

† Philoſophical Tranſactions, vol. xxii. p. 982.

circum-

circumstances of the roots being (according to Mr. Richardson's observations *) only visible when the water is low, where a channel was cut, which has left them uncovered.

Little doubt can be entertained of the moory islets of Sutton being a part of this extensive and subterraneous stratum, which, by some inroad of the sea, has there been stripped of its covering of soil. The identity of the levels; that of the species of trees; the roots of these affixed, in both, to the soil where they grew; and, above all, the flattened shape of the trunks, branches, and roots found in the islets (which can only be accounted for by the heavy pressure of a superinduced stratum), are sufficient reasons for this opinion.

Such a wide-spread assemblage of vegetable ruins, lying almost in the same level, and that level generally under the common mark of low-water, must naturally strike the observer, and give birth to the following questions:

1. What is the epoch of this destruction?
2. By what agency was it effected?

In answer to these questions, I will venture to submit the following reflections:

The fossil remains of vegetables hitherto dug up in so many parts of the globe, are, on a close inspection, found to belong to two different states of our planet. The parts of vegetation, and their impressions, found in mountains of a cotaceous, schistous, or even sometimes of a calcareous nature, are chiefly of plants now existing between the tropics, which could neither have grown in the latitudes in which they are dug up, nor have been carried and deposited there by any of the acting forces under the present constitution of nature. The formation, indeed, of the very mountains in which they are buried, and the nature and disposition of the materials which compose them, are such as we cannot account for by any actions and re-actions which in the actual state of things take place on the surface of the earth.

* Philosophical Transactions, vol. xix. p. 528.

We muſt neceſſarily recur to that period in the hiſtory of our planet, when the ſurface of the ocean was at leaſt ſo much above its preſent level as to cover even the ſummits of thoſe ſecondary mountains which contain the remains of tropical plants. The changes which theſe vegetables have ſuffered in their ſubſtance is almoſt total; they commonly retain only the external configuration of what they were. Such is the ſtate in which they are found in England by Llwyd; in France by Juſſieu; and in the Netherlands by Burtin; not to mention inſtances in more diſtant countries. Some of the impreſſions or remains of plants found in ſoils of this nature, which were, by the more ancient and enlightened oryctologiſts, ſuppoſed to belong to plants actually growing in temperate and cold climates, ſeem, on accurate inveſtigation, to have been part of exotic vegetables. In fact, whether we ſuppoſe them to have grown near the ſpot where they are found, or to have been carried thither from different parts by the force of an impelling flood, it is equally difficult to conceive how organized beings, which, in order to live, require ſuch a vaſt difference in temperature and in ſeaſons, could live on the ſame ſpot, or how their remains could (from climates ſo widely diſtant) be brought together in the ſame place by one common diſlocating cauſe. To this ancient order of foſſil vegetables belong whatever retains a vegetable ſhape, found in or near coal mines, and (to judge from the places where they have been found) the greater part of the agatized woods. But from the ſpecies and preſent ſtate of the trees, which are the ſubject of this memoir, and from the ſituation and nature of the ſoil in which they are found, it ſeems very clear that they do not belong to the primeval order of vegetable ruins.

The ſecond order of foſſil vegetables, comprehends thoſe which are found in the ſtrata of clay or ſand; materials which are the reſult of ſlow depoſitions of the ſea and of rivers, agents ſtill at work under the preſent conſtitution of

our planet. Theſe vegetable remains are found in ſuch flat countries as may be conſidered to be of a new formation. The vegetable organization ſtill ſubſiſts, at leaſt in part; and their vegetable ſubſtance has ſuffered a change only in colour, ſmell, or conſiſtence; alterations which are produced by the development of their oily and bituminous parts, or by their natural progreſs towards rottenneſs. Such are the foſſil vegetables found in Cornwall by Borlaſe; in Eſſex by Derham; in Yorkſhire by De la Pryme and Richardſon; and in foreign countries by other naturaliſts. Theſe vegetables are found at different depths, ſome of them much below the preſent level of the ſea, but in clayey or ſandy ſtrata (evidently belonging to modern formation); and have no doubt been carried from their original place, and depoſited there by the force of great rivers or currents, as it has been obſerved with reſpect to the Miſſiſſippi *. In many inſtances, however, theſe trees and ſhrubs are found ſtanding on their roots, and generally in low or marſhy places above, or very little below, the level of the ſea.

To this laſt deſcription of foſſil vegetables the decayed trees here deſcribed certainly belong. They have not been tranſported by currents or rivers; but, though ſtanding in their native ſoil, we cannot ſuppoſe the level in which they are found to be the ſame as that in which they grew. It would be impoſſible for any of theſe trees or ſhrubs to vegetate ſo near the ſea, and below the common level of its water; the waves would cover ſuch tracts of land, and hinder any vegetation. We cannot conceive that the ſurface of the ocean has ever been lower than it now is; on the contrary, we are led, by numberleſs phenomena, to believe that the level of the water in our globe is now below what it was in former periods: we muſt therefore conclude, that the foreſt here deſcribed grew in a level high enough to permit its vegetation; and that the force (whatever it was)

* Le Coudriniere ſur les Depôts du Miſſiſſippi, Journal de Phyſique, vol. xxi. p. 230.

which deſtroyed it, lowered the level of the ground where it ſtood.

There is a force of ſubſidence (particularly in ſoft ground), which, being a natural conſequence of gravity ſlowly though perpetually operating, has its action ſometimes quickened and rendered ſudden by extraneous cauſes, for inſtance by earthquakes. The ſlow effects of this force of ſubſidence have been accurately remarked in many places: examples alſo of its ſudden action are recorded in almoſt every hiſtory of great earthquakes. The ſhores of Alexandria, according to Dolomieu's obſervations, are a foot lower than they were in the time of the Ptolemies. Donati, in his Natural Hiſtory of the Adriatic, has remarked, ſeemingly with great accuracy, the effects of this ſubſidence at Venice; at Pola in Iſtria; at Liſs, Bua, Zara, and Diclo, on the coaſt of Dalmatia. In England, Borlaſe has given, in the Philoſophical Tranſactions*, a curious obſervation of a ſubſidence, of at leaſt ſixteen feet, in the ground between Sampſon and Treſcaw iſlands in Scilly. The ſoft and low grounds between the towns of Thorne and Gowle in Yorkſhire, a ſpace of many miles, has ſo much ſubſided in latter times, that ſome old men of Thorne affirmed, "that whereas they could before ſee little of the ſteeples (of Gowle), they now ſee the church-yard wall†." The inſtances of ſimilar ſubſidence, which might be mentioned, are innumerable.

The force of ſubſidence, ſuddenly acting by means of ſome earthquake, ſeems to me the moſt probable cauſe to which the uſual ſubmarine ſituation of the foreſt we are ſpeaking of may be aſcribed. It affords a ſimple, eaſy explanation of the matter; its probability is ſupported by numberleſs inſtances of ſimilar events; and it is not liable to the ſtrong objections which exiſt againſt the hypotheſis of the alternate depreſſion and elevation of the level of the ocean; an opinion which, to be credible, requires the ſupport of a great num-

* Vol. XLVIII. p. 62. † Gough's Camden.

ber

ber of proofs leſs equivocal than thoſe which have hitherto been urged in its favour, even by the genius of a Lavoiſier*.

The ſtratum of ſoil, ſixteen feet thick, placed above the decayed trees, ſeems to remove the epoch of their ſinking and deſtruction, far beyond the reach of any hiſtorical knowledge. In Cæſar's time, the level of the North Sea appears to have been the ſame as in our days. He mentions the ſeparation of the Wahal branch of the Rhine, and its junction to the Meuſe; noticing the then exiſting diſtance from that junction to the ſea, which agrees, according to D'Anville's inquiries†, with the actual diſtance. Some of the Roman roads, conſtructed, according to the order of Auguſtus, under Agrippa's adminiſtration, leading to the maritime town of Belgium, ſtill exiſt, and reach the preſent ſhore‡. The deſcription which Roman authors have left us, of the coaſts, ports, and mouth of rivers on both ſides of the north ſea, agree in general with their preſent ſtate; except in the places ravaged by the inroads of this ſea, more apt, from its force, to deſtroy the ſurrounding countries than to increaſe them.

An exact reſemblance exiſts between Maritime Flanders and the oppoſite coaſt of England, both in point of elevation above the ſea, and of the internal ſtructure and arrangement of the ſoils. On both ſides, ſtrata of clay, ſilt, and ſand, (often mixed with decayed vegetables), are found near the ſurface; and, in both, theſe ſuperior materials cover a very deep ſtratum of blueiſh or dark-coloured clay, unmixed with extraneous bodies. On both ſides they are the lowermoſt part of the ſoil, exiſting between two ridges of high lands‖, on

* Mem. de la l'Acad. de Paris, 1789, p. 351.

† Notices des Gaules, p. 461.

‡ Nicholas Bergier, Hiſt. des Grands Chemins des Romains, Ed. de Bruxelles, vol. II. p. 101.

‖ Theſe ridges of high land, both on the Britiſh and the Belgic ſide, muſt be very ſimilar to each other, ſince they both contain parts of tropical plants in a foſſil ſtate. Cocoa-nuts and fruits of the Areca are found on

on their reſpective ſides of the ſame narrow ſea. Theſe two countries are certainly coeval; and whatever proves that Maritime Flanders has been for many ages out of the ſea, muſt, in my opinion, prove alſo that the foreſt we are ſpeaking of was long before that time deſtroyed and buried under a ſtratum of ſoil. Now it ſeems proved from hiſtorical records, carefully collected by ſeveral learned members of the Bruſſels Academy, that no material change has happened to the lowermoſt part of Maritime Flanders during the period of the laſt two thouſand years *.

I am therefore inclined to ſuppoſe the original cataſtrophe which buried this foreſt to be of very ancient date; but I ſuſpect the inroad of the ſea, which uncovered the decayed trees of the iſlands of Sutton, to be comparatively recent. The ſtate of the leaves and of the timber, and alſo the tradition of the neighbouring people, concur to ſtrengthen this ſuſpicion. Leaves, and other delicate parts of plants, though they may be long preſerved in a ſubterraneous ſituation, cannot remain uninjured when expoſed to the action of the waves and of the air. The people of the country believe that their pariſh-church once ſtood on the ſpot where the iſlets now are, and was ſubmerged by the inroads of the ſea, and that at low water their anceſtors could even diſcover its ruins; that their preſent church was built to ſupply the place of that which the waves waſhed away, and that even their preſent clock belonged to the old church. So many concomitant circumſtances, though weak teſtimonies, incline me to believe their report; and to ſuppoſe that ſome of the ſtormy inundations of the North Sea, which in theſe laſt centuries have waſhed away ſuch large tracts of land on its ſhores, took away a ſoil reſting on clay, and at laſt uncovered the trees which are the ſubject of this paper.

the Belgic ridge. The petrified fruits of Sheppey, and other impreſſions of tropical plants on this ſide of the water, are well known.

* Vide ſeveral papers in the Bruſſels Memoirs; alſo *Journ. Phyſ.* Vol. XXXIV. p. 48.

XIII. *On*

XIII. *On an Epidemical Diſeaſe among Cats.* By J. F. Blumenbach *.

THE diſeaſe among the cats, which prevailed lately in Denmark and various other countries of Europe, and which in Lombardy deſtroyed a great many of theſe uſeful animals, induced the Council of Health at Pavia to make an inquiry into the nature of it, and to cauſe the reſult to be publiſhed by one of their members, Profeſſor Brera, in a ſmall but intereſting pamphlet under the title of *Memoria ſull' attuale Epidemia de' Gatti* †.

The cats attacked by this diſeaſe ſeemed dejected and weak, and had an averſion to approach man; crawled about as if under great oppreſſion; would neither eat nor drink; and could not endure any of the three plants of which they are commonly ſo fond, *Marum verum*, Valerian, and Cat's mint. In the courſe of the diſeaſe the weakneſs and dullneſs increaſed; they could ſcarcely ſupport themſelves on their legs; their hair ſtood erect; they let their tail hang down, and their head droop ſo that their neck appeared as if prolonged; their ears were flabby and cold; the eyes ſeemed ſmaller, and the pupil contracted; the tongue was dry, and covered with yellow ſlime; they diſcharged from the mouth a whitiſh green foam, were for the moſt part coſtive, breathed ſhort, and had a quick feveriſh pulſe, accompanied with burning heat. They at length became like mere ſkeletons, were ſeized with violent convulſions, and generally died on the fourth or fifth day of the diſeaſe; which, according to the ſymptoms, was a nervous fever, accompanied with dejection. It is, however, far from being always mortal; and many of the animals attacked by it recovered again gradually, without any aſſiſtance.

* From *Voigt's Magazin für der neueſten zuſtande der Naturkunde*, Vol. I. Part 3.

† It was publiſhed at Pavia laſt year (1798), and conſiſts of twenty-ſix pages quarto.

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The method in which this diſeaſe was treated was entirely Brownonian; that is, half an ounce of Cyprus wine, with a ſcruple of pulveriſed valerian root, was given four times a day to the diſeaſed animals: aloes, and the juice of garlic, were adminiſtered in ſome ſpiritous vehicle, and alſo fumigations with vinegar. The propoſal for deſtroying every cat attacked by this diſeaſe was, with great propriety, rejected; but it was at the ſame time ordered, that thoſe which died of it ſhould be buried at a ſufficient depth in the earth; that the bodies ſhould be covered with lime; and that the places where they were found dead ſhould be waſhed with vinegar, ley of wood-aſhes, or lime-water. It was recommended alſo to ſeparate, as much as poſſible, ſound animals from thoſe infected; to give them nouriſhing food; to lay before them, in particular, their three favourite plants; and to fumigate them often with the ſteam of vinegar.

That excellent phyſician and naturaliſt Profeſſor Schacht, of Harderwyk, informed me, by a letter dated in May 1796, that the cats in his neighbourhood had for ſome weeks been attacked by a diſeaſe which bore ſome reſemblance to a prurient eruption. The violent itching occaſioned a defluxion of the eyes, which continually watered, and they at length became blind; their teeth at the ſame time dropped out, and they died ſoon after with lamentable cries. It had been obſerved in the preceding months, from February to April, that their cries in the night-time, on account of their pairing, had been extraordinarily ſtrong and loud.

Dr. Darwin, in his *Zoonomia* *, mentions another epidemia which prevails at times among the cats, and which he calls *Parotidis felina*. It announces itſelf by a violent fever with inflammation, and abundant ſuppuration in the region of the ſalival glands beneath the lower jaw. He compares it to a diſeaſe lately known called the Mumps (*Angina parotidea*), and is inclined to believe that it was firſt communicated to cats by infection from the human race. He men-

* Vol. II. p. 229.

tions alſo a diſeaſe which affects the neck and head of cats, by which the greater part of theſe animals in Weſtphalia died; and refers to a paſſage in Sauvage's *Noſologia**, which however, in an extract of that work in three large volumes octavo †, now before me, I have not been able to find.

XIV. *On the Preparation of Crayons uſed for Drawing, from the Paſte of Reddle.* By C. F. Lomet ‡.

In moſt drawing-ſchools, and particularly thoſe at a diſtance from the capital, many difficulties are experienced for want of good crayons. Thoſe ſawed from red chalk, which are in common uſe, are almoſt always hard, gritty, and often of an unequal conſiſtency; ſo that the touches in the drawings for which they are uſed can never have the ſtrength or correctneſs neceſſary to produce the deſired effect. The only good crayons uſed in France are manufactured excluſively at Paris, where they are ſold very dear: the beſt ſort have been long known by the name of the paſte crayons of *Deſmarets*, who apparently was the inventor. As no author who has written on the compoſition of theſe crayons has pointed out the proportions of the ingredients neceſſary to be uſed, I made many trials with every combination of the ſubſtances that appeared to me proper for making them. I rejected thoſe products which did not anſwer the objects of my reſearch; and I here ſubjoin thoſe mixtures that gave me ſatisfactory reſults.

Theſe pencils are compoſed of the ſofter kind of reddle, which is an oxyde of iron mixed with earth of an argillaceous nature, and called *hematites*, or bog-ore. It muſt be incorporated with ſome agglutinating ſubſtance, ſuch as gum, ſize, or reſin; to which ſometimes ſoap is added, to

* Noſol. cl. X. art. 30. 8.

† Amſt. 1763.

‡ From the *Annales de Chimie*, No. 90. an. 7.

ſoften

ſoften the compoſition. Inſtead of reddle the other red oxydes of iron may be uſed, ſuch as colcothar of vitriol, &c.; and in that caſe they ſhould be choſen ſoft to the touch, and of a lively colour; for thoſe uſed in commerce are often mixed with too much clay, which gives them a dull yellowiſh caſt that ought to be avoided. I attempted to incorporate theſe ſubſtances with the whites of eggs and the albumen of blood; but crayons compoſed in this manner were not good.

The beſt reddle, in lumps, ſhould be ſelected and ground with pure water on a marble ſlab, as is done in the preparation of colours for painting; taking care to moiſten it as much as is neceſſary to make the grinding ſtone glide, and to employ as little water as poſſible. When it is intended to prepare a large quantity of this ſubſtance, this operation becomes very difficult and expenſive: in that caſe a different method muſt be uſed. The reddle muſt be pounded and ſifted through a fine ſieve, then diluted with a large quantity of water in a trough; where, after it has been well ſtirred round, it ſhould be left a few minutes to ſettle, in order that the groſſer particles may precipitate themſelves to the bottom. The water, which is ſtrongly impregnated with the finer particles, is then poured off, and ſuffered to ſettle for twenty-four hours. The clear water on the top is then poured off again, and a very fine ſediment will thus be obtained, which muſt be pounded and waſhed once more. The ſediment of the firſt waſhing muſt be treated in the like manner, and the proceſs is repeated until the whole be reduced to the utmoſt fineneſs.

The gum, ſize, or ſoap, deſtined to give the crayon the neceſſary degree of ſolidity, muſt be diſſolved ſeparately. Theſe ſolutions muſt be carefully mixed with the pounded reddle, and the watery particles muſt be evaporated by being expoſed to the ſun or to the heat of a gentle fire, taking care to turn the paſte often till it has acquired a conſiſtence ſomewhat harder than butter: the crayons are then to be formed in the moulds.

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The moulding may be performed two ways: the firſt is, to ſpread out the paſte on a board, in which are cut grooves rather broader at the top and round at bottom; and of any length, ſize, and depth, proportioned to the intended ſize of the crayons. The ſecond, which is the better method, is to force the paſte through a pipe or funnel of an orifice equal to the ſize of the crayon. The paſte thus formed may be left to dry ſlowly in a cool place under the ſhade, in order to prevent cracks, which too haſty deſiccation might produce. When the rods are dry, they are to be cut into pieces of the deſired length: the edges muſt then be taken off; after which they muſt receive the firſt cutting, to give them a blunt point. The laſt operation is to ſcrape them, in order to take off the hard outward coat formed on the ſurface while they are drying, and which would prevent them from making any marks. It may be neceſſary to rub a ſmall portion of oil into the grooves of the wood, that the paſte may not adhere too cloſely to the moulds.

Gum arabic and iſinglaſs are the two ſubſtances to be preferred for mixing with the powder. It will be ſufficient to diſſolve the gum and ſoap in cold water; but the iſinglaſs muſt firſt be cut into ſmall pieces, then put into hot water, and diſſolved in *balneo mariæ*. Theſe ſolutions ſhould be well diluted with water, that they may be made to paſs through a hair ſieve in order to remove any foreign particles. As it is difficult to incorporate the paſte with the iſinglaſs, they muſt both be heated and mixed over a fire with a heat equal to that of boiling water. The paſte muſt be well mixed before it is moulded, in order that it may be uniformly incorporated with the ſolution, and that there may not remain any hard lumps. The beſt way would be to beat it with a peſtle or mallet, and to pound it again for ſome time before it is put into the moulds.

No ſoap muſt be employed but for thoſe crayons in which gum is uſed. In all the trials I have made with iſinglaſs and

ſoap,

ſoap, not one of them ſucceeded: and it muſt neceſſarily be ſo; for, the exceſs of alkali in the ſoap, operating on the gelatinous matter, deſtroys its agglutinating quality. As the crayons for which ſoap has been uſed are of a browner caſt, it would appear that this combination abſtracts the oxygen from a part of the red oxyde of iron, and gives it a brown tint by making it approach the ſtate of martial æthiops. I have remarked, that all the paſtes prepared with oxyde of iron, even when pure water alone is uſed, grow brown on the exterior ſurface as they dry: this takes place in a more ſenſible manner when they are expoſed to the action of the ſun; which ſeems to ariſe from the light abſtracting a portion of oxygen from the oxyde of iron. At ſome future period I ſhall enter into a farther inquiry reſpecting the chemical properties of theſe preparations; but at preſent I ſhall content myſelf with pointing out the proceſſes which have conſtantly ſucceeded with me, and in ſuch a way that they may be put in practice any where with ſucceſs.

The crayons compoſed in this manner have every good property that can be deſired; they do not coſt one quarter the common price: but it muſt be obſerved, that their compoſition requires great nicety in regard to the quantity of the materials, becauſe the leaſt variation occaſions conſiderable difference in the quality of the paſte. Particular care muſt alſo be taken to guard againſt the errors that may ariſe from the waſte, which is unavoidable during the courſe of the operation. The beſt means to prevent it will be, to fix by experiments the quantity of water and of ingredients which the pounded reddle and the ſolutions form before the mixtures are made. By means of the following tables, which exhibit the quantity of ingredients to be uſed for the different kinds of crayons, it will be eaſy to know what proportion of gum, iſinglaſs, or ſoap, muſt be employed for a determined quantity of reddle, or red oxyde of iron.

Indication

Indication of the Subſtances to be uſed, their Quantities, and what they will produce.

I. Dry reddle, or red oxyde of iron, 1 ounce; gum arabic, dry, 18 grains.—Theſe crayons are very tender, but they may be employed for large deſigns. As they are the kind in which the leaſt gum is uſed, they have not ſufficient conſiſtence for any other purpoſe.

II. Reddle, &c. 1 ounce; gum 21 grains.—Strong crayons, a little tender, but excellent for large drawings.

III. Reddle 1 ounce, gum 24 grains, or rather $25\frac{1}{2}$ grains.—Soft and ſolid crayons: they are the beſt that can be employed for common uſe.

IV. Reddle 1 ounce, gum 27 grains.—Crayons rather firm, but not hard; uſeful for drawings that require delicacy.

V. Reddle 1 ounce, gum 30 grains.—Very firm crayons, proper for drawings in which every ſtroke is intended to be given.

VI. Reddle 1 ounce, gum 33 grains.—Very hard crayons, which cannot be uſed without ſome force. The largeſt quantity of gum that can be employed is uſed in their compoſition: with more they would be uſeleſs.

VII. Reddle 1 ounce, gum 22 grains, white hard ſoap 30 grains.—Theſe crayons have a little browner caſt than the former; they are of a very good conſiſtence, and can be eaſily cut. All crayons, however, in the compoſition of which ſoap is employed, are attended with this fault, that the ſtrokes they make have a ſhining appearance if the touches are repeated a little too ſtrongly. No other experiment with ſoap ſucceeded. Theſe crayons have a perfect reſemblance to thoſe made by Deſmarets.

VIII. Reddle 1 ounce, iſinglaſs 36 grains.—Crayons of a brilliant colour, and excellent for uſe. If leſs iſinglaſs is employed they become brittle; and if more, they are too hard.

XV. *Deſcrip-*

XV. *Description of* HUMBOLT's *New Portable Barometer**.

TO have a barometer compoſed of ſeveral parts which could be eaſily put together, and which ſhould correct itſelf at each obſervation like an aſtronomical inſtrument, were the reaſons which induced M. Humbolt to deviſe the preſent conſtruction. Tralles, the learned aſtronomer of Berne, has judiciouſly obſerved, that all barometers are liable to be broken when the tube is fixed to the ſcale which belongs to it. In Humbolt's barometer the tube is diſtinct from the ſcale; and when the tube breaks, its place can be ſupplied by another even on the top of a mountain. The tube, the lower part of which is repreſented by *abc* (fig. 1. pl. VII.) is cemented into an iron one *bc*, two inches long, terminating in a nut *c*, which receives a ſcrew to the depth of $2\frac{1}{2}$ lines: the end of the ſcrew is ſquare. When the tube is filled with mercury, and ſcrewed cloſe, it is put into a tube of copper lined with flannel, and covered on the outſide with leather. This caſe may be carried as a cane; the head *d* of the ſcrew being kept, as far as poſſible, in a vertical poſition. If the entrance of air be apprehended, it will lodge itſelf under *d*. In that caſe turn the ſcrew and pour a drop of mercury upon it before it is ſhut. The whole tube may be examined to ſee that the mercury is not ſeparated by air bubbles; an advantage wanting in the Engliſh barometers, in which the tubes are half concealed. The mahogany pillar *egf* (fig. 2.) contains the mercury, to be poured into it after it has been ſcrewed into its ſtand *gh* (fig. 3.), ſupported by three feet that fold over each other. The interior part of the column forms a hollow parallelopipedon, the ſquare aperture of which is exactly equal in ſize to the ſquare of the ſcrew *cd*. In puſhing the tube *klma* (fig. 4.) into this aperture until *cd* be above the level of the mercury, you turn the tube to the right, by laying hold of it with one hand between *lm*.

* From the *Journal de Phyſique*, an. 7.

As

As the square *cd* cannot then turn, being held fast in the pillar, the screw is loosened, *cd* sinks down floating on the mercury, and the atmospheric air has free communication with the mercury in the tube. The Torricellian vacuum is formed under *k*, and the mass of mercury in the column is increased. The scale *no* (fig. 4.) is attached to a wooden rod *nop*, formed of two pieces of timber of a different kind, and screwed at *p* and *q* to the mahogany pillar. Turn the three screws *rrr* until the vertical position of the instrument is announced by the plummet *s*. If you fix the scale to the tube *ka*, by screwing close the screws *l* and *m*, there will be too much mercury in the pillar. The point *o* of the barometer is placed in the aperture of the cock *s*, and you will have a *constant level* by opening that cock and suffering the mercury, which you must collect in a small vase, to flow down. In order that the ivory cock *s* may not open of itself, there is, at *t*, a fork which by a screw can be fixed in each position to prevent it. When the observation is made, you place in *g e* a small cushion, or covering, held by two screws *v v*, which prevent the escape of the mercury while you are walking; or you dismount the instrument by again pushing the tube *klm* (unscrewed at *m* and *l*) to the bottom of the pillar *f*, where you turn the square *cd*. The Torricellian vacuum is by these means filled, and you turn the tube to the left, holding it with your hand between *l* and *m* until you observe that *cd* has caught, and that the aperture of the tube is closed. You then draw out the tube with *cd* well shut in order to inclose it in its case. There is a loss of a few drops of mercury which adhere to the iron. One of these instruments, constructed two years ago, has remained unhurt during a great many journies over the most rugged roads and the steepest mountains. More time is required to make an observation with it than with a common barometer; but it is the only one perhaps which could with certainty be used, were it to become deranged even in the deserts of Thibet.

Theſe inſtruments are now made at Berlin, Weimar, Dreſden, Vienna, and Paris. On coming from a cold to a very warm temperature the ſcrew *cd* muſt be looſed before you approach the fire. This inſtrument has an advantage by which it is diſtinguiſhed from all others: it is the only one in which the ſize of the Torricellian vacuum depends on the obſerver: the height of the mercury remains the ſame to whatever depth it be plunged in the mercury, provided you take care each time to adjuſt the level by the cock. Muſcati has proved, that the barometric height is affected by the ſize of the vacuum on account of the attraction of the glaſs in *k*, and becauſe the *minimum* of air which the vacuum contains is more or leſs dilated. In Humbolt's barometer, the ſame Torricellian vacuum exiſts on the tops of the mountains as in the valleys.

The different pieces of which this inſtrument conſiſts are contained in one cylinder, which may be carried on the ſhoulder like a fuzee. Several tubes may be contained alſo in a walking-ſtick. Having for two years meaſured the height of different mountains with Humbolt's barometer, and others conſtructed on the old principles, no ſenſible differences were obſerved, though this operation, for various reaſons explained by Tremblay, is ſtill very far from perfection.

XVI. *Poſtſcript to Volta's Letters on Animal Electricity* *.

SOME new facts, lately diſcovered, ſeem to ſhew that the immediate cauſe which excites the electric fluid, and puts it in motion, whether it be an attractive or a repulſive power, is to be aſcribed much rather to the mutual contact of two different metals, than to their contact with moiſt conductors. But, though it cannot be denied that in the latter caſe there exiſts an action, it is proved that it exerts itſelf in a far more

* See page 59 and 163.

conſider-

conſiderable degree when the two metals mutually touch each other. There ariſes by the mutual contact, for example, of ſilver and tin, an action or power by which the former communicates the electric fluid, and the latter receives it; or the ſilver ſuffers it to eſcape, and the tin attracts it. This produces, when the circle is rendered complete by moiſt conductors, a ſtream, or continual circulation of the fluid. When the circle is complete, there is an accumulation in the tin at the expence of the ſilver; which indeed is very ſmall, and far under the point neceſſary to enable it to announce itſelf by the moſt delicate electrometer. I have however been able, by the aſſiſtance of my condenſer, conſtructed on a new plan, and ſtill better by Nicholſon's Doubler, to render it very perceptible: I ſhall here communicate the reſult obtained by my experiments, which I made ſome time ago with great ſatisfaction.

Exper. I. The three plates of the doubler are of braſs. I took two ſtrong wires, one of ſilver and the other of tin, and brought the former into contact with the moveable plate, and the other with one of the fixed plates; while they both reſted on the table, or, what is better, on moiſt paſteboard, or any other moiſt conductor, ſo as to be in communication by the intervention of one or more conductors of the ſecond claſs. I ſuffered the apparatus to remain ſome hours in this ſtate, then removed the two wires, and put the machine in motion. After 20, 30, or 40 revolutions, (or more when the atmoſphere was not dry, or the inſulation imperfect,) I brought one of my ſtraw electrometers into contact with the moveable plate, and obſerved indications of poſitive electricity (+E) which aroſe to 4, 6, 10 degrees, and more. If I ſuffered it to touch the fixed plates, I had the correſponding indications of the oppoſite kind of electricity (−E).

The ſilver, therefore, poured the elaſtic fluid into the braſs plate when it had been ſome time in contact with it; and the tin attracted it from the other plate, which was alſo of

braſs, while in contact with it. This was confirmed by the following experiment, which is a real *experimentum crucis*.

II. I reverſed the experiment, ſo that the ſilver was in contact with one of the fixed plates, and the tin with the moveable one. The electricity which I obtained from the latter, after the apparatus had remained a ſufficient time in that poſition, was negative (−E); while that of the fixed plate was poſitive (+E).

III. I applied only the tin wire to the moveable plate, and inſulated the two fixed ones, or brought them into communication with the table or any other moiſt conductors with which the tin wire was in contact. This ſimple contact of the tin with the braſs, of which the moveable plate conſiſts, is ſufficient to excite in it a very ſmall degree of negative electricity; only a longer time is required.

Thoſe acquainted with the action of electric atmoſpheres, and the conſtruction of the doubler, will need no farther explanation to enable them to comprehend the mode of action of this very ingenious inſtrument; how the electricity, once obtained from the moveable plate, muſt occaſion an oppoſite kind in the fixed plates, and *vice verſa*; how the oppoſite kinds of electricity are increaſed by each revolution of the machine, &c. In the preſent experiment, therefore, when the moveable plate is −E, the fixed plate muſt be +E.

III. This is the reverſe of the former. The piece of tin was applied to one of the fixed plates, and the moveable one was inſulated from all metallic contact. The reſult was now reverſed; that is, the fixed plates were electrified negatively, and the moveable one had poſitive electricity.

All theſe experiments ſucceed much better, and in a ſhorter time, if, during the mutual contact of the different metals, the moveable plate be oppoſite to either of the other two that are fixed; but ſtill better when a piece of thick paper, ſuch as a card, not moiſt, and of a thickneſs equal to the intermediate ſpace, is placed between the two plates that ſtand oppoſite to each other. It is of advantage to leave the card

ſome

ſome time in its place, and not to remove it till the moment when the metals in contact are removed and the machine put in motion. To render the inſulation complete, and make the contact of the metals immediate, without the leaſt moiſture, which would be highly prejudicial, it will be proper to place the apparatus in the ſun. Half an hour, and often leſs, will then be ſufficient to obtain the required electricity, &c.; whereas, in other caſes, ſeveral hours are neceſſary before the deſired reſult can be obtained. A repreſentation of this experiment is exhibited by fig. 21, 22, 23 and 24, (Plate I.) L L L (fig. 21 and 22) are the three braſs plates of the doubler; A the piece of ſilver which is in contact with one of theſe plates; E the piece of tin applied to the other plate, which is oppoſite to the former; *a a* the moiſt conductor, or chain of moiſt conductors which form a communication with the pieces of metal. When the ſilver, as in fig. 21, is in contact with the anterior moveable plate, it gives up to it a little of the electric fluid, and the latter accumulates as much of it as poſſible; conſequently the electricity of the plate becomes poſitive, as the ſign + of the plate ſhews: whereas the tin attracts the electric fluid from the correſponding fixed plate, which by theſe means has negative electricity, as the ſign (—) of the plate indicates; and it even communicates this electricity to the other fixed plate, which therefore has the ſign (—) alſo.

In fig. 22, every thing is reverſed: the moveable plate is negatively electrified (– E), while the two fixed plates become poſitive (+ E).

Laſtly, in the 23d and 24th figure, it is ſeen, that the tin abſtracts the electric fluid from the braſs plate with which it is in contact. This plate is therefore negatively electrified, or has — E; and by the action of its atmoſphere occaſions poſitive electricity (+ E) in the other plate ſtanding oppoſite, which is in communication, either with the third plate, as fig. 23, or, what is ſtill better, with other conductors, as fig. 24. Theſe oppoſite electricities increaſe af-

terwards with each revolution of the machine; the action of which, according to the theory of electric atmoſpheres, produces this effect to the degree mentioned, and juſtifies the appellation of doubler of electricity, which has been given to this inſtrument.

I now come to the experiments, which ſhow that we are to ſeek for the cauſe which calls forth the action of the electric fluid; which excites it, of whatever kind it be; determines its tranſition, &c. much rather in the mutual contact of the metals, than in the contact of the moiſt conductors with theſe metals. Though, according to every circumſtance, we muſt admit ſome action of this kind in the latter contact, it cannot be denied that the former is certainly the moſt effectual. At preſent I ſhall only mention the two following experiments, which I contrived in ſuch a manner that they may ſerve to explain a queſtion of this kind.

V. I left the two fixed plates of braſs without making any alteration; took off the third moveable plate, and ſupplied its place by one of tin; and arranged the machine in ſuch a manner that the latter ſtood oppoſite to one of the other two plates. I then applied to this tin plate a bit of braſs, and to the oppoſite fixed plate of braſs a piece of tin. After a convenient time, (for example an hour, when the weather was perfectly dry,) I took away the two pieces of metal, or only that of braſs, and made the moveable plate of tin, which was in contact with the piece of braſs, to revolve about thirty times. It then gave me very perceptible marks of poſitive electricity.

VI. I reverſed the former experiment, and made the piece of braſs touch the braſs plate, and the piece of tin the plate of the ſame metal. I, however, obtained nothing, or almoſt nothing; even when the apparatus was left a much longer time in that ſituation, and when the machine had made twice or three times as many revolutions.

Theſe two experiments are repreſented by fig. 25 and 26: where L is the piece of braſs; E that of tin; and *a a* the moiſt

moiſt conductors which connect the two different pieces of metal.

In the arrangement of fig. 26, the ſame contact of different metals, viz. braſs on the one ſide, and tin on the other, with the ſame kind of moiſt conductor, takes place, as well as in the preceding experiment of fig. 25. The addition of the electric fluid in the one, and the abſtraction of it in the other, ought therefore equally to take place, though in an inverted order, when the action on the fluid calls forth the moving power, by this contact of the two metals L, E, with the moiſt conductor between them; and yet this is not the caſe, as no ſigns of electricity are obtained even after a long time, and when the machine has been cauſed to make twice or three times as many revolutions. The condition eſſentially neceſſary to obtain electricity is, that the different metals muſt be in contact with each other, which is the caſe in fig. 25, but not in fig. 26.

When the machine has been repeatedly turned, ſomething may be obtained. This ariſes either from ſome ſmall remains of old electricity, which could not be deſtroyed or diſſipated in the time during which the arrangement of fig. 26 was continued; or even from freſh electricity, which the moveable plate may have obtained from the atmoſphere or vapours during the pretty conſiderable time of the machine being in a ſtate of revolution; or ſome accidental difference, either between the two tin or the two braſs pieces, may be the cauſe of ſome action on the electric fluid, or of ſome derangement in regard to the equilibrium. In the laſt place, the contact of the moiſt conductor with the tin on the one ſide, or with the braſs on the other, may have a different action, which, in my opinion, muſt be very ſmall, but yet is not entirely without effect.

As it is now proved that, according to the arrangement of the ſixth experiment, nothing, or almoſt nothing, is obtained by 40, 60, and even 80 revolutions of the doubler, while a great deal is obtained by that of the fifth with 20

or 30, we muſt therefore conclude that the contact of two metals of a different kind with moiſt conductors, without the mutual contact of theſe metals themſelves, (which is wanting in the ſixth experiment, where braſs is in contact with braſs, and tin with tin,) produces nothing or almoſt nothing; and that, on the contrary, the mutual contact of the two metals of a different kind, which takes place in the fifth experiment, produces the whole, or almoſt the whole, effect.

XVII. *A Statement of the Progreſs in the* Vaccine Inoculation; *and Experiments to determine ſome important Facts belonging to the Vaccine Diſeaſe. By* GEORGE PEARSON, M.D. F.R.S. *Phyſician to St. George's Hoſpital*, &c.

THE collection of teſtimonies which I publiſhed, in November laſt, in my *Inquiry concerning the Hiſtory of the Cow-pox*; and the Circular Letter, which I iſſued in March, ſtating the progreſs of the *Vaccine Inoculation*, and containing thread impregnated with *matter*, have procured me much information. In particular, through the recommendation of the *Surgeon-general, Thomas Keate, Eſq.* the new practice has been introduced into the army; of which a valuable report has been already communicated. I have been alſo ſo fortunate as to obtain permiſſion to practiſe the *new inoculation* in certain ſituations where great numbers would have been inoculated for the ſmall-pox. The caſes from theſe ſources, and a pretty large ſtock from private practice, form a valuable body of evidence, by means of which the profeſſional public will be enabled to eſtimate (I do not ſay preciſely) the value of the *new practice*; and alſo anſwer many of the queries, and ſupply ſome of the deficient parts of the hiſtory of the vaccine diſeaſe, which were ſtated in the *Inquiry* above mentioned. But ſuch are my occupations at preſent, and in all likelihood ſuch they will be for a conſiderable time, that I cannot at this time arrange, for the uſe of the

the public, the valuable materials tranſmitted to me. It will, however, perhaps be not without utility at this time firſt to ſtate a few general reſults from the vaccine inoculation; and ſecondly, to relate ſome *trials*, from which I apprehend concluſions can warrantably be drawn to promote the inveſtigation now going forward.

Not much more than ſix months have elapſed ſince the opportunity was afforded, by the breaking out of the *vaccine diſeaſe* in two principal milch farms near London, of obtaining matter for propagating the ſame diſeaſe among human creatures. The *new inoculation* was immediately introduced in London, and ſoon afterwards in the neighbourhood, as well as in many provincial ſituations. It is with ſincere ſatisfaction that we can now reckon, at the feweſt, 2000 perſons who have paſſed through the cow-pox by inoculation. But in this number I include the very large proportion furniſhed by him who, ſo beneficially to the public, and honourably to himſelf, poſſeſſes the office of phyſician to the Small-pox Hoſpital. From the above experience we receive, as I expected, important information.

1. Of the above number it appears that *one* patient died; (Woodville's Reports, p. 151.) and to avoid controverſy, let us allow that the death was occaſioned ſolely by the inoculation. Now, according to the juſteſt calculation I have been able to make, as in the inoculated ſmall-pox one in 200 * dies from the diſeaſe, it is evident, in the preſent ſtate of

* I am fully aware that ſo great a proportion as one in 200 will not be allowed by many practitioners. And to perſons who have been told, and believe, that inoculation for the ſmall-pox "ſcarcely ever does any harm" —that certain practitioners have inoculated many thouſands without loſing a patient—that others have told their friends "they never had a fatal inoculated caſe in their whole lives"—I ſay to ſuch perſons, no advantage, on the ſcore of ſaving life, will be allowed from the cow-pox. But I have converſed with many candid and experienced practitioners, and they are well ſatisfied that I am warranted in the above ſtatement of deaths in the inoculated variola. I beg leave to ſay farther, that I believe more perſons

of the practice, that the proportion of fatal caſes in the inoculated ſmall-pox, to the inoculated cow-pox, is as 10 to 1.

2. The conſtitutional affection, or fever, which occurs in the cow-pox about the 9th day after inoculation, is much more conſiderable in many caſes than was apprehended from the firſt account by Dr. Jenner, although in a great proportion of caſes it is extremely ſlight, and in many cannot be obſerved at all. But I muſt correct my ſtatement in March laſt, in which I ſaid, "Although the extreme caſes of the ſevere kind, which ordinarily occur in the ſame number of caſes in the inoculated ſmall-pox, did not occur in the new practice, and although many of the patients were even more ſlightly diſordered conſtitutionally, yet the whole amount of the conſtitutional illneſs ſeemed to be as great as in the ſame number of patients in the inoculated ſmall-pox." Since that report, or at leaſt for the laſt four months, as far as I have obſerved and been able to learn from others, the whole amount of the conſtitutional illneſs was not one half of the whole amount in an equal number of patients inoculated for the ſmall-pox. Now, whether the greater mildneſs of the diſeaſe depended on the different ſtate of the human conſtitution in the ſummer from that of winter, as ſeems to me moſt probable; or that it depended on the difference in the ſtate of the vaccine matter, muſt be determined by future experience in the ſame ſeaſons.

3. The moſt remarkable difference in the practice of the laſt winter, and preſent ſummer, has been with regard to the eruptions which ſo often occurred, eſpecially in the Small-pox Hoſpital; which eruptions, in many inſtances, could not

ſons in proportion have died of the inoculated ſmall-pox within a few years, than died in the ſame time 20 years ago. And this may be accounted for from the unwarrantable aſſertions of many inoculators, from whom a great part of the public have imbibed the opinion, that the inoculated ſmall-pox was not attended with any danger; hence the practice is often truſted in the hands of perſons not ſufficiently acquainted with the treatment fit for different ſtates of the human conſtitution.

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be diſtinguiſhed from thoſe of the ſmall-pox, and which were wholly unexpected from the original deſcription by Dr. Jenner. No explanation hitherto given conſiſts with the obſervations relative to theſe eruptive caſes: but the facts are as Dr. Woodville ſtates (Med. Mag.), that they have occurred much leſs frequently this ſummer than in the ſpring and winter preceding. In my private practice, not a ſingle caſe with eruptions reſembling the ſmall-pox has occurred theſe laſt four months, and but a ſmall proportion with any eruptions of other kinds. From my correſpondents I have not had a ſingle caſe of eruptions like the variolous ſince that of Dr. Redſearne's of Lynn; not one of this ſort in Mr. Kelſon's, of Seven Oaks, report of about 100 patients; not one in Dr. Mitchell's, of Chatham, of about 50 patients; not one in the report of near 100 patients from Dr. Harriſon of Horncaſtle, communicated to the Rt. Hon. Sir Joſeph Banks; and, in ſhort, not one caſe with theſe eruptions appears in the accounts from my other correſpondents.

4. The arms have manifeſted, in many inſtances, a much more extenſively ſpreading red areola around the inoculated part than is uſual in the ſmall-pox; which redneſs ſometimes extended over the greater part of the whole arm. This appearance is very alarming to both the patient and the inexperienced practitioner; but no danger ſeems to be attendant on ſuch a ſtate of the parts, for it diſappears in at moſt two or three days, by no means gives pain in proportion to its appearance, and, in the caſes I have ſeen, affects the conſtitution very little. I would rather call this ſpreading redneſs of the ſkin *erythema* than eryſipelas. As to phagedenic ulcers, as they have been called, enſuing from the inoculated part, many ſore arms have been produced; but nine out of ten were occaſioned, or at leaſt much aggravated, by the tightneſs of the clothes; by allowing the linen to ſtick to the ſore; by ſcratching the puſtule; and ſometimes by emollient poultices. The experience we have had, then, ſince January laſt, in London and in the country, does not agree exactly

actly with Dr. Jenner's account concerning the ſtate of the arms: he thinks ſome new applications of a cauſtic nature neceſſary, in many caſes, to prevent ſecondary ſymptoms from the ſores; but in Dr. Woodville's Report, p. 155, my correſpondents, and my own practice, there has not been found any want of applications for ſuch a purpoſe.

5. Concerning the important point of the certainty of the action of the cow-pox on the human conſtitution in producing unſuſceptibility of taking ſubſequently the ſmall-pox; I can only at preſent ſay, that I have inoculated many ſcores with ſmall-pox matter after the vaccine diſeaſe, and never with the effect of exciting the ſmall-pox. But I have had accounts ſent to me, not of people taking the ſmall-pox after the inoculated cow-pox, but of theſe taking the ſmall-pox after the cow-pox in the caſual way. I have, indeed, been deſired to ſee even ſome of my own patients who, I was acquainted, had taken the ſmall-pox after the cow-pox; but theſe caſes turned out to be either thoſe in which the cow-pox had not in reality preceded, or they were caſes of merely local affection from the inoculated ſmall-pox. With reſpect to the facts of other practitioners, I ſhall at a future time make ſome remarks on them, to render their accounts conſiſtent with thoſe of Dr. Jenner, Dr. Woodville, and mine. In the mean time I will not allow that any perſon's evidence is on this point much to be depended upon, unleſs he really know what are characters of the cow-pox puſtule, and what are thoſe of the variolous and ſome other common eruptions.

From the preceding general reſults, without entering into a more particular account, I think we may ſafely conclude, that the cow-pox inoculation is attended with advantages ſufficient to force its way ſpeedily into general practice, and that of courſe it will ſuperſede and ultimately extinguiſh the ſmall-pox: but this concluſion is only drawn proviſionally, *viz.* that no new facts ſhall ariſe adverſe to the experience now poſſeſſed.

With regard to the ſecond object of this paper, Dr. Jen-

ner, very uſefully to human ſociety, and very honourably to himſelf, firſt publiſhed ſome FACTS, which I thought it my duty, in common with other members of the profeſſion, to inveſtigate, and have laid before the public. Among theſe *facts* the 4th and 5th were aſſerted by me in theſe terms:

IV. *A perſon having been affected with the ſpecific fever and local diſeaſe produced by the cow-pox poiſon, is liable to be again affected, as before, by the ſame poiſon; and yet ſuch perſon is not ſuſceptible of the ſmall-pox.*

V. *A perſon is ſuſceptible of the cow-pox who has antecedently been affected with the ſmall-pox.*

Neither of theſe facts being ſupported by any analogy, a great part of the public ſeemed inclined to diſbelieve them; and not only inclined to diſbelieve theſe facts, but the credit of the others was for obvious reaſons thereby weakened. It may be ſeen in my *Inquiry*, that I thought the aſſertions ſtood in need of confirmation, which I was not only unable to procure, but contravening evidence was obtained. Some of my correſpondents not only aſſerted that men were not affected more than once, but that the ſame cows had not been known to be affected more than once. It was alſo poſitively aſſerted by ſome, that "a perſon is not liable to the infection of the cow-pox after going through the ſmall-pox, (p. 49, *Inquiry*:) and I ſaw perſons pitted with the ſmall-pox who had been much expoſed to the cow-pox without taking it, (*Ibid.* p. 50.) Notwithſtanding my confidence in Dr. Jenner's evidence, I could not help pointing out, in the following words, what I apprehended was a ſource of error in both caſes:—"The evidence for this fact (viz. IV.), to my apprehenſion, only proves ſatisfactorily that the *local affection* of the cow-pox may occur in the ſame perſon more than once; but whether the *peculiar fever* alſo occurs more than once in the ſame perſon from the cow-pox poiſon does not appear certain, and muſt be determined by future obſervations made with a particular view to this point." Farther: I was ſo diſſatisfied that I wrote to Dr. Jenner to

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anſwer my query, Whether, in the inſtances of the cow-pox occurring more than once in the ſame perſon, it was certain that the ſpecific fever was preſent more than once? The Doctor very obligingly anſwered my letter, and ſays, (ſee Dr. Jenner's Letter, p. 99. of my *Inquiry*,) "You may be aſſured that a perſon may be repeatedly affected *both locally and generally* by the cow-pox; two inſtances of which I have adduced, and have many more in my recollection." But he very candidly adds: "Nevertheleſs, on this important point I have ſome reaſon to ſuſpect, that my diſcriminations have not been, till lately, ſufficiently nice."

With reſpect to Fact V. I ſaid in my *Inquiry*, p. 49: "It ſeems ſufficiently authenticated that people may have the cow-pox after they have had the ſmall-pox; but it will require more nice attention to ſatisfy the query, Whether, in ſuch caſes, the cow-pox affects the whole conſtitution, or is only a local affection?" Subſequently to this obſervation I find Dr. Jenner himſelf, from a theoretical conſideration, offers as a "conjecture what experiment muſt finally determine that they who have had the ſmall-pox are not afterwards ſuſceptible of the primary action of the cow-pox virus." (Farther Obſervations, &c. by E. Jenner, M. D. &c. p. 32.)

I ſhall now relate the *trials* I have inſtituted, and the *obſervations* I have made, to obtain *determinations* with reſpect to theſe important queſtions of facts.

Trials to determine whether or not Perſons are ſuſceptible of having the COW-POX PUSTULE *and* FEVER, *who have undergone the Small-pox.*

The four firſt-named gentlemen being engaged with me in proſecuting phyſical inquiries, were deſirous to experience, in their own perſons, the effects of the *vaccine poiſon*.

1. Mr. Dangerfield was inoculated in one arm by means of a puncture with a lancet ſtained with freſh but dried matter, rendered fluid by ſteam juſt before it was inſerted. The other arm was inoculated with thread impregnated with *vac-*

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cine matter by paſſing it through the ſkin. On viewing the arms in three days time, that with the thread appeared inflamed, ſhowing a red elevated ſmall ſpot; the other arm, which had been punctured, barely ſhewed a red mark. The punctures had ſmarted for about twenty-four hours, but no other effects were produced. Theſe red ſpots diſappeared in a few days.

In three weeks further the inoculation was again inſtituted, but with fluid lymph applied, immediately from the puſtule of a patient preſent, to punctures in each arm. More ſmarting and more inflammation were produced by this inoculation than by the former. A ſmall quantity of pus was produced in the little red ſpots from the punctures in about ſix or ſeven days, but no diſorder aroſe in the whole conſtitution.

Mr. Dangerfield was next inoculated in one arm with variolous matter. In the evening of the day of inoculation inflammation appeared, which increaſed to a greater degree and extent than from the vaccine inoculations. A ſmall phlegmonic tumor in the part inoculated with variolous matter continued for a fortnight, during which time it ſuppurated, and the pus from it did not heal in leſs than three weeks further. There was no conſtitutional affection; but there was pain in the arm-pit in about five days from the inoculation.

2. Mr. Pollock was inoculated in each arm with a lancet armed with fluid matter immediately on taking it from a patient. A little ſmarting was felt for a day or two, and the parts inoculated were red for ſeveral days; but no puſtules aroſe, nor conſtitutional affection.

3. Mr. Perkins was inoculated by puncturing *one* arm with a lancet ſtained with recent *vaccine matter*, and the other was inoculated with *variolous matter*. A red ſpot was ſeen on each of the parts inoculated the day following; and an itching ſenſation, eſpecially from the vaccine matter, was experienced for a day or two. The parts remained elevated and inflamed a little for a few days further, and then got

well without ſuppurating, or being attended by any general diſorder.

4. Mr. Armitage, whoſe conſtitution was fat and muſcular, was inoculated in each arm, with a lancet ſtained with limpid vaccine matter, immediately on taking it from a patient preſent. A ſmall red ſpot was obſerved the day following, and a little burning ſenſation was complained of; the red ſpots grew larger and larger for four or five days, and at length produced a ſmall unequal hard tumor, in which a little pus was generated; but the parts ſoon got well without any attending diſorder of the whole conſtitution.

In a fortnight after this, each arm was inoculated with variolous matter. More inflammation than from the vaccine inoculation aroſe in a few days, with ſmall tumors, which ſuppurated: the parts inoculated remained ſore for more than a fortnight, but no feveriſh ſymptoms ever appeared.

5. G. P. a boy 12 years of age, who had gone through the ſmall-pox ten years before, was inoculated in one arm with recent vaccine matter, which had been dried on a lancet, and was moiſtened juſt before it was inſerted. The day following not ſo much as a red ſpot of the part inoculated was ſeen, nor had there been any uneaſy ſenſation. He was therefore inoculated a ſecond time, but with fluid lymph immediately from a patient.

The day after the ſecond inoculation an itching ſenſation of the punctured part was complained of, which continued for two or three days. The part punctured had a ſmall red elevated ſpot upon it the day after the inoculation, which grew gradually larger for four or five days, and became a little phlegmonic tumor, but without any red ſurrounding areola. In a few days the little ſwelling ſubſided, but a red and rather ſore ſpot remained for a week longer. No diſorder of the whole conſtitution was perceived.

6. Dr. Woodville inoculated me in one arm with vaccine lymph

lymph from a ſubject preſent. The punctured part ſmarted a little all the remainder of the day of the inoculation, and alſo the day following. In twenty-four hours a red ſpot on the inoculated part was ſeen exactly like that which is often ſeen in the ſame time when either the vaccine or variolous infection has taken effect, and which increaſed for another day; but after this the redneſs vaniſhed, and no ſore was left.

I once accidentally punctured the back of my hand with a lancet which had fluid vaccine matter upon it. The conſequence was, a circumſcribed, very ſmall, red, hard tumor: this remained for a fortnight, then ſuppurated, and afterwards burſt. The part ſoon healed, but left a very ſmall ſuperficial cicatrix.

As belonging to this head, I mention, that I have ſeen ſeveral inſtances of nurſes having ſmall, red, conical tumors on their lips and cheeks, and ſometimes hands; evidently from the application of cow-pox matter of the children under their care during the vaccine inoculation. Theſe little tumors ſometimes remained for ſeveral weeks, and a particle of pus was formed in them: they never were attended by any fever ſymptoms, nor by any ſurrounding erythematous areola.—I here ſpeak of nurſes who had long before paſſed through the ſmall-pox.

I have no heſitation to refer the following caſes to this head of unſuſceptibility of taking the cow-pox to having previouſly gone through the ſmall-pox.

A ſervant of Thomas King, Eſq. about 18 years of age, was brought up during his infancy under circumſtances in which he could get no teſtimony to his having had, or *not* having had, the ſmall-pox. Not having undergone this diſeaſe to his own knowledge, it was thought adviſeable, in order to reſiſt the ſmall-pox, with which his fellow-ſervant was ſeized, to inoculate him for the cow-pox. This I did on Thurſday the 23d of March, in one arm with matter on a lancet, and in the other with dried matter on a bit of thread.

4th Day, Sunday 26. The parts inoculated had ſmarted

for the two firſt days, and they now were red and a little elevated, as if the infection had taken effect.

6th Day, Tueſday 28. Inflammation had almoſt entirely gone off: inoculated a ſecond time in both arms with matter from a different patient.

3d Day of ſecond Inoculation, Thurſday 30. Punctured parts appeared inflamed.

6th Day, Sunday April 2. Inflammation had diſappeared. Inoculated a third time with limpid fluid matter from a patient preſent, and with which matter I had excited the vaccine diſeaſe in ſeveral perſons.

7th Day of third Inoculation, Friday April 7. The parts inoculated had inflamed and felt painful for two or three days, but were now well.—Inoculated him a fourth time with *ſmall-pox* matter in both arms. A little inflammation aroſe, but nothing more.

This young man frequently viſited his fellow-ſervant in the ſmall-pox, and ſhook hands with him, at the Small-pox Hoſpital, while under my care for the cow-pox inoculation. In this caſe, either the ſmall-pox had already affected the conſtitution, or ſome other diſpoſition exiſted, rendering it equally unſuſceptible of the ſmall-pox and cow-pox.

From Dr. Mitchell of Chatham, whoſe report is now before me, I learn, that there were ſeveral inſtances of ſoldiers to whom the cow-pox could not be communicated; and although they had no recollection themſelves of having had the ſmall-pox, it was moſt probable they had paſſed through it. If I had ſeen any caſe of genuine cow-pox puſtule and ſpecific fever in a conſtitution which had previouſly ſuffered the ſmall-pox, I ſhould have related it; but I ought to mention that ſuch a caſe has fallen under the obſervation of Dr. Woodville, (*Reports*, p. 52 and 143.) I ſhall never object to the teſtimony of ſo experienced a phyſician without more than uſual conſideration; but I cannot avoid here obſerving, that the evidence in his caſe, of the patient having had the ſmall-pox *when a child*, is merely that of the patient; and

I ſubmit

I ſubmit to Dr. Woodville, whether or not that evidence is admiſſible to build upon, now that we have the above unequivocal contravening caſes of the fact aſſerted. But I truſt the Doctor will be leſs tenacious of this inſtance, as he himſelf tells us that he failed to excite the vaccine diſeaſe by inoculating ſeveral patients who were recovering from the natural ſmall-pox. (*Reports*, p. 144.)

Whatever impreſſion the above inſtances may have made on my own mind, I do think they will produce conviction in the mind of every practitioner, *that it is a law of the human animal œconomy to be rendered unſuſceptible of the cow-pox fever and ſpecific puſtule by undergoing the ſmall-pox.* Hence I find that my expectation of the hands of phyſic being ſtrengthened by the poſſeſſion of a ſure means of exciting an innocent fever is not realiſed, (*Inquiry*, p. 81;) but I feel ſome conſolation from the proſpect of the new inoculation being more ſpeedily introduced by the removal of one obſtacle, viz. the fears of many perſons, who have already paſſed through the ſmall-pox, that they would be liable to the cow-pox, if the diffuſion of the infection of it became extenſive by the vaccine inoculation. Another advantage ſuggeſted in my *Inquiry*, p. 92, is now, I think, greatly confirmed; namely, an *advantage for thoſe who are not certain whether or not they have had the ſmall-pox, but poſſeſs ſo great a dread of this diſeaſe as not to be able to ſubmit to inoculation for it.* I congratulate ſuch perſons on the diſcovery of a teſt to which I apprehend the more timorous minds will ſubmit: for if the *ſpecific puſtule* and *fever* do not take place from the inoculation of the cow-pox poiſon, they may be aſſured, that either they have already paſſed through the ſmall-pox, or that their conſtitutions are not ſuſceptible of it.

It now ſeems to me, that the following facts are eſtabliſhed on the ground of experience:—

I. *A conſtitution which has undergone the ſmall-pox, is unſuſceptible of again undergoing this diſeaſe.*

II. *A conſtitution which has not undergone the ſmall-pox, but which has undergone the cow-pox, is unſuſceptible of undergoing the ſmall-pox.*

III. *A conſtitution which has not undergone the cow-pox, but which has undergone the ſmall-pox, is unſuſceptible of undergoing the cow-pox.*

Now, if the variolous poiſon deſtroys the ſuſceptibility of the conſtitution to the future agency of this poiſon, in the reſpect of its producing the ſmall-pox; and if the cow-pox poiſon deſtroys the ſuſceptibility of the conſtitution to the future agency of the variolous poiſon, in the reſpect of its producing the ſmall-pox; and if the variolous poiſon deſtroys the ſuſceptibility of the conſtitution to the future agency of the vaccine poiſon, in the reſpect of its producing the cow-pox; it ſeems demonſtrated, that the ſame ſtate of unſuſceptibility of the conſtitution, with reſpect to the future agency of the variolous poiſon, is produced equally by the agency of the variolous poiſon, and by the vaccine poiſon. But if the variolous poiſon produces unſuſceptibility of the conſtitution to the future agency of the vaccine poiſon, and the vaccine poiſon produces unſuſceptibility to the future agency of the variolous poiſon, it ſeems alſo demonſtrable, that the following 4th propoſition is true; viz.

IV. *A conſtitution which has undergone the vaccine diſeaſe, is unſuſceptible of again undergoing that diſeaſe from the agency of the vaccine poiſon*: becauſe a ſtate of unſuſceptibility, with reſpect to the agency of the variolous poiſon, is produced by the vaccine poiſon (*2d propoſ.*); and a ſtate of unſuſceptibility, with reſpect to the agency of the vaccine poiſon, is produced by the variolous poiſon (*3d propoſ.*): but the ſtate of the conſtitution being the ſame in the two caſes, whether it be produced by the variolous or vaccine poiſon, with reſpect to unſuſceptibility, it ſeems inevitably, in courſe, that unſuſceptibility of the conſtitution to the future agency of the vaccine poiſon is produced by the vaccine

diſeaſe:

disease: and the demonstration in course could be given of proposition 1, on the ground of the 2d and 3d *proposition*, that unsusceptibility of the constitution to the agency of the variolous poison is produced by the variolous disease, if this were not already proved by abundant experience. At a future time, however, I shall relate the observations and experiments to confirm this *à priori* conclusion; 1st, because these proofs will increase the validity of the 3d *proposition*; and 2dly, because I do not mean to offer this demonstration as infallible, like mathematical.

From the preceding reasoning it may be imagined, that I consider the cow-pox and small-pox as only varieties of the same species of disease; and that therefore the name *variola vaccina* is appropriate, although I endeavoured to show that it was unjust, and tended to mislead, by giving erroneous notions, (*Inquiry*, *p.* 108). But it must here enter into our contemplation, that the same state of an animal or other substance, in a certain respect, may be produced by very different things; and the phenomena attending their agency may be very different from one another. It is so in the instances under consideration; and further, in order to establish resembling things to be *varieties of the same species*, we ought to be able to trace them to one common origin, or to show that they all agree in what should be reckoned essential properties. Now hitherto it has not appeared that the cow-pox has arisen from the small-pox, or the small-pox from the cow-pox. If it be said, that in some of the eruptive instances of the cow-pox, the pustules could not be distinguished from the small-pox, it should be considered that it has not been yet shown, that in any case the small-pox has changed into the cow-pox;—that the cow is susceptible by inoculation of the human matter of the cow-pox, but not of the small-pox; and that the pustules resembling the small-pox, which occur in the cow-pox, afford matter which, I believe, produces in some cases (if not, perhaps, in so great a proportion as originally) the cow-pox in its usual mild way,

viz. a puſtule in the inoculated part only, and a ſlight fever. Hence I humbly am of opinion, but ſubmit the queſtion to the deciſion of ſcholars, that the uſe of the denomination *variola vaccina* is a tranſgreſſion of the law in philology, and repugnant to ſound logic.

Extended as this paper is, much beyond the limits propoſed, I cannot confine to myſelf the gratification from the reports of the *new inoculation*. I ſhall only mention, however, one or two of them. The ſenſation excited on the Continent, by the vaccine practice, has been much more conſiderable than in our own iſland, as I learned firſt from Dr. Marcet, and ſince by a letter from Dr. Peſchier. At Vienna Dr. Ferro inoculated two of his own children with vaccine matter which I tranſmitted: and next, Dr. De Carro inoculated two of his own children. An accurate journal of theſe laſt caſes was kept by Dr. De Carro, which he has had the complaiſance to communicate to me. The above patients had the diſeaſe in the uſual mild way, and were ſubſequently inoculated for the ſmall-pox, but without effect. Dr. Frank, it is expected, will adopt the vaccine inoculation; as it appears will be generally done at Vienna. I often ſend matter on a thread, which is to be kept for a long time, in a bottle filled with quite dry hydrogen or nitrogen gas. I ſhall ſoon have reports from Portugal, and other parts of the Continent.

In Scotland the new inoculation has not been leſs ſucceſsful. Dr. Anderſon, of Leith, informs me he has inoculated above 80 perſons—that Dr. Duncan and others have begun the practice at Edinburgh; and that it has been introduced in Dundee, Paiſley, and Dalkeith.

If the vaccine inoculation proceed with equal mildneſs as it has done the laſt four months, doubtleſs the variolous inciſion muſt in no remote period be ſuperſeded. And if ſuch an event ſhould take place, poſterity will behold with amazement the prejudices and inattention of their predeceſſors to the application of a fact in practice, by which a formidable

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and loathsome disease was extinguished—a fact well known, time immemorial, to almost every farmer in half a dozen counties of England, but neglected till *Jenner* had the courage to indicate the advantages of it to society. If I were to name a parallel instance of inattention or prejudice, it should be the neglect of inoculation for the small-pox, till it was introduced into England from Constantinople; although it had been practised, time immemorial, in the Barozzo mountains, on the frontiers of Gallicia, in the same rude manner as it is at this day *.

XVIII. *Query respecting the natural Boundaries between Europe and Asia.*

To the Editor of the Philosophical Magazine.

SIR,

THE variety of useful geographical communications in your valuable scientific miscellany, encourages me to hope that some of your correspondents may be able to inform me of what many of the geographical publications, to which I have had recourse, give no satisfactory account: it is, What are the boundaries between Europe and Asia? The last edition of the Encyclopædia Britannica, to my great surprise, gives nothing but a string of contradictions. Under the article *Oby*, that river is said to form the boundary between Europe and Asia; yet, in the wretched maps given in this expensive work, the range of mountains known by the name of Oural is marked as the boundary. Neither are the Oural mountains mentioned at all in their proper place; but, under the article *Mountain*, "the Ouralic chain is said to form a

* This intelligence was communicated to me by a Portuguese nobleman, whose opportunities of information and accuracy authorise me to mention the fact; but an attested account from some of the inhabitants is intended for me. See also a book written by *Jacobus à Castro Sarmento*.

natural boundary between Europe and Asia." And in Vol. VII. p. 39, when enumerating the boundaries of Europe, it is said to be "separated from Asia in part by the Archipelago, as also by the Black Sea, then by the river Don till it comes near the river Volga or Wolga, and then it is parted from Asia by this last, and afterwards by the river Oby."

The greatest instance of inaccuracy, however, is when, enumerating the boundaries of Asia, Vol. II. p. 393, it is said to be "separated from Europe by the Mediterranean Sea, the Archipelago, the Black Sea, the Palus Meotis, the Don, and the Dwina, which fall into the White Sea." Such are the contradictions to be met with in that heterogeneous, though in many instances justly celebrated work. The gazetteers of Watson, Salmon, and Brookes, uniformly contradict themselves, describing the river Oby as being the boundary between these two quarters of the world, and their maps representing the chain of Oural mountains as the boundary. It is not so much to be wondered at in gazetteers, which are, generally speaking, catchpenny publications, servilely copying from each other, even their very faults, except Cruttwell's lately published, and an excellent little pocket one, Peacock's: it is, however, to be regretted, that the editor of that most useful and excellent geographical grammar, Guthrie's I mean, has also fallen into this error.

If any of your correspondents will inform me how this matter is, it will be considered as a favour by one who has already received much entertainment and information from the Philosophical Magazine.

August 12, 1799. L. M.

P. S. There is a similar mistake to be found in most geographical descriptions of Ireland; the county of Clare being enumerated amongst the counties of Munster, and the map representing it as part of the province of Connaught, which certainly appears its most natural appropriation.

INTEL-

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

MINERALOGICAL SOCIETY OF JENA.

IN the public ſitting of the Mineralogical Society of Jena, held on the 26th of May at the Ducal Palace, Mr. Bodo, from Hungary, read a paper to prove that organiſation cannot be denied to any natural body, and that the diviſion into organiſed and unorganiſed is conſequently inadmiſſible. M. Stark, the ſecretary, read a paper ſent in by M. Mihalik, of Dopſchau in Hungary, on the following queſtion: Whether mineralogy could exiſt as a ſcience without the help of chemiſtry? — Dr. Bonzel propoſed, that various minerals now arranged under one general name, ſhould in future, on account of their peculiar marks of difference, be ſeparated in the ſyſtem, and be diſtinguiſhed by particular names. Thus, for example, that the red zeolite, from Faſſa in the Tyrol, ſhould be called *Faſſaite*, to diſtinguiſh it from the real Icelandic zeolite; and that the ſchorl, from Oiſans in Dauphiné, ſhould be called *Oiſanite*, to diſtinguiſh it from that of Thum in Saxony.

LITERARY NEWS.

That moſt learned, indefatigable, and amiable cultivator of ſcience, R. Kirwan, Eſq. is now in London, where he has been for the laſt three months. With ſincere pleaſure we can announce that this revered veteran is printing and preparing for the preſs three valuable works:—

1. *A Treatiſe on the Analyſis of Mineral Waters:* a moſt difficult and nice ſubject, and which will require all Mr. Kirwan's mental powers and knowledge to treat of ſucceſsfully.

fully. Nothing has been done on this ſubject ſince the new ſyſtem of chemiſtry has been generally adopted.

2. A Memoir on the intereſting and fundamental Part of Chemical Science, the preciſe Quantities of Menſtrua and Baſes contained in the double Salts with alkaline, earthy, and metallic Baſes: whence may be deduced the preciſe Forces of the Affinities of Bodies.

3. A work on Geology; which will be made not only to accord with the Moſaic Doctrine, but to confirm it greatly.

Of this philoſopher permit us to indulge in the wiſh—

Serò in cœlum redeat.

NATURAL HISTORY.

The following inſtance of the ſagacity of the elephant, which is taken from a late French Journal, may ſerve as an additional confirmation of what has been ſo often repeated by various authors both ancient and modern:—

" A ſentinel belonging to the menagerie at Paris, anxious to diſcharge his duty, was extremely careful, every time he mounted guard near the elephants, to deſire the ſpectators not to give them any thing to eat. This conduct was not much calculated to procure him any friendſhip from the elephants. The female, in particular, beheld him with a very unfavourable eye, and had ſeveral times endeavoured to correct his unwelcome interference by beſprinkling his head with water from her trunk. One day, when a great number of people were collected to view theſe animals, the opportunity ſeemed convenient for receiving, unperceived, a ſmall bit of bread; but the rigorous ſentinel was on duty. The female, however, placed herſelf before him, watched all his geſtures, and, the moment he opened his mouth to give his uſual admonition to the company, diſcharged in his face a large ſtream of water. A general laugh enſued; but the ſentinel having calmly wiped his face, ſtood a little to one ſide, and continued as vigilant as before. Soon after

he

he found himſelf under the neceſſity of repeating his admonition to the ſpectators not to give the elephants any thing; but no ſooner had he done ſo than the female laid hold of his muſket, twirled it round in her trunk, trod it under her feet, and did not reſtore it until ſhe had twiſted it into the form of a ſcrew."

INTRODUCTION OF THE CAMEL AT THE CAPE OF GOOD HOPE.

Notwithſtanding the great number of travellers who have attempted to penetrate into the interior part of Africa by the way of the Cape of Good Hope, the diſtricts left unexplored are immenſe when compared to thoſe which have been viſited. One of the greateſt obſtacles to travelling in theſe wild and parched regions, is the want of proper beaſts of burthen; for it is well known that cattle cannot long endure thirſt, and that numbers of them employed on that ſervice by travellers have died by the way, and thereby rendered their attempts to proceed farther uſeleſs. This fact muſt be well known to thoſe who have read Vaillant's Travels. Profeſſor Heeren of Gottingen propoſes therefore, in order to remove this difficulty, the introduction of the camel at the Cape of Good Hope. "There can be no doubt," ſays he, "that this animal would thrive there, as the climate is exactly the ſame as that of the countries where it is now found. It would no doubt ſucceed as well in the latitude of 35° S. as the lat. of 35° N. in Syria. The exploring of the interior parts of Africa is not the only advantage which might be derived from the introduction of the camel at the Cape: of what utility would ſuch a beaſt of burden be to the planters, many of whom live at a great diſtance from the Cape town, and can at preſent ſend their productions thither in no other manner than in waggons drawn by four oxen! The principal point, however, would be the opening a commercial intercourſe with the interior part of the country. It cannot be doubted that the ſouthern extremity of Africa is

more productive than the northern, and why might not the Cape be the centre of a trade which in future may become very extenſive? But without the aſſiſtance of the camel it could never be attempted. The preſent period is the more favourable for putting this propoſal in execution, as the Cape is now in the poſſeſſion of Great Britain; and even if it ſhould be given up at the next peace, the Britiſh government would by this ſervice to the colony raiſe a monument worthy of its dignity: the expence of tranſporting a few camels from Mogador would be very trifling."—We agree in opinion with Profeſſor Heeren, and think his propoſal well worth attention.

ANIMAL ELECTRICITY.

Dr. Chladni, well known by his diſcoveries in regard to ſound, has lately announced the following obſervation on animal electricity, which we here give in his own words:

"It might be conjectured, when electricity manifeſts itſelf in animals, that it would be equally diffuſed throughout the whole body on account of the conducting power of the interior parts; yet we are taught by experience, that the oppoſite kinds of electricity take place in the torpedo as well as in cats, though in a leſs degree; and perhaps the caſe is the ſame in other animals. Some years ago I remarked that a cat which had been rendered electric by ſtroking with the dry hand, eſpecially when lying near the fire on dry days in winter, exhibited oppoſite kinds of electricity; and that the principal ſeat of the one was in the head, and of the other in the back, about two inches from the tail. This phenomenon appeared above all when the animal was upon a chair ſtuffed with hair, and covered with a woollen cloth, by which it was completely inſulated. When the head, and in particular the tip of the noſe, or of one of the ears, was touched by the finger, there appeared a ſmall electric ſpark; the caſe was the ſame when the extremity of the back was touched; and in this manner ſparks could be drawn alternately from the anterior and poſterior parts of the body in the ſame manner

ner as ſparks can be drawn alternately from an inſulated charged jar. I afterwards obſerved the ſame thing in another cat; but, as at that time I paid little attention to this part of philoſophy, and ſuppoſed that the exiſtence of the oppoſite kinds of electricity in animals might have been known, I made no farther experiments, and could not determine which of theſe electricities was negative and which poſitive. I leave it, therefore, to others to examine this phenomenon with more accuracy."

METEOROLOGY.

A very ſingular work was publiſhed laſt year at Liegnitz in Sileſia, entitled *Aphoriſms reſpecting the Influence of War on the Atmoſphere, Weather and Fertility of the Earth.* Among the author's obſervations are the following: If a cubic foot of gun-powder, when it explodes, exerciſes a force equal to twenty-nine millions of pounds, it by theſe means produces a great change in the elaſticity of the air; the whole maſs of the atmoſphere, within a large circumference, is violently torn, and billows of air are produced, which roll themſelves upwards and agitate the vapours contained in them. It cannot therefore be denied that the diſcharging of fire-arms and cannon during battles and ſieges, and even at great reviews, muſt have an influence on the atmoſphere, and on the ſtate of the clouds and weather. He quotes inſtances in the time of the ſeven years war, of clouds and vapours being diſperſed by the exploſions of the cannon; and aſſerts that, during his travels through the Tyrol, he ſaw on ſeveral occaſions, to uſe his own expreſſion, the clouds "ſhot dead." He obſerved in the neighbourhood of Liegnitz, while the regiment of Wartenſleben were going through their exerciſe, that the clouds were broken by the exploſions, and that the murmuring of the wind, and the agitation of the leaves of the trees, and the ſmall feathers ſuſpended from any body, were ſometimes ſtronger, ſometimes weaker, according as the troops fired by battalions or companies. The barometer

roſe and fell at each exploſion; and water in a veſſel, at the diſtance of five hundred paces, was violently agitated. There have been inſtances of the noiſe of heavy cannonades, in the laſt and preſent war, being heard at the diſtance of more than forty miles. Nay, the thunder of cannon penetrates even into the interior parts of the earth, and to the bottom of the ſea, ſo that whales and herrings have been frightened away to the diſtance of two hundred miles. The author, from theſe principles, endeavours to account for certain ſingularities which prevailed in the weather in ſome parts of Germany in the year 1797; and to ſhew that the quantity of gun-powder fired in the time of war may have a ſenſible effect on the fertility of gardens and fields. In the ſeven years war above a million of pounds of powder were fired off in Europe; and it may with certainty be affirmed that no leſs a quantity has been conſumed in the preſent war againſt the French.

NEW BASIS FOR BLACK PAINT.

A moſt excellent baſis for black paint has been diſcovered in the Lead-mines of Nant Gwider, in the Vale of Conway, by Mr. Goodwin of Llanrooſt, proprietor of ſeveral mines, of which a deſcription and analyſis will be given in ſome future number of the Philoſophical Magazine, together with that of ſeveral other ſubſtances he has diſcovered in North Wales, and which it is preſumed will be of conſiderable utility.

SUGAR FROM THE BEET-ROOT.

Profeſſor Göttling, of Jena, has announced a ſmall work, which he intends to publiſh ſoon, on the preparation of ſugar from the beet-root. The Profeſſor in his proſpectus obſerves, that the various kinds of beet with which he made experiments, muſt be treated in a quite different manner from the ſugar-cane, or the method employed by Margraaf, in order to obtain from them good ſugar. In regard to the quantity of ſugar which they produce, he found very little variation,

tion. Some have ſaid that 100 pounds of roots are ſufficient for eight pounds of ſugar; but Profeſſor Göttling could obtain from 100 pounds of roots no more than two pounds and a half. As the Profeſſor has promiſed to give a full account of the proceſs in his pamphlet, it will no doubt be intereſting to thoſe who wiſh to make experiments on this ſubject.

SIZE MADE OF POTATOES.

One of the beneficial uſes of potatoes, not perhaps generally known, is, that the ſtarch of them, quite freſh, and waſhed only once, may be employed to make ſize, which, mixed with chalk, and diluted in a little water, forms a very beautiful and good white for ceilings. This ſize has no ſmell; while animal ſize, which putrefies ſo readily, always exhales a very diſagreeable odour. That of potatoes, as it is very little ſubject to putrefaction, appears from experience to be more durable in tenacity and whiteneſs; and for white-waſhing ſhould be preferred to animal ſize, the decompoſition of which is always accompanied with unhealthful exhalations.

DEATHS.

On the 29th of April, at Leyden, David Van Royen, Profeſſor of Botany in that Univerſity, in the 70th year of his age.

On the 7th of this month, at his houſe in Newman-ſtreet, John Bacon, Eſq. R.A. the well-known ſculptor. He was a native of Southwark, and, when a child, diſtinguiſhed himſelf by moulding figures in clay, and very early in life obtained prizes from the Academy.

On Thurſday the 22d inſtant, in the 49th year of his age, Mr. Benjamin Thomas Pouncy, engraver; an artiſt of the firſt eminence in his profeſſion. He was the brother-in-law and moſt diſtinguiſhed of the diſciples of Woollett, with whoſe vigour and richneſs of ſtyle he has with peculiar felicity united the freedom and ſimplicity of Vivares; "and,

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with a maſter's hand and poet's fire," has ſecured to himſelf the praiſe of originality, by blending both with his own view of Nature. To enumerate his engravings, and comment on them in the detail, would be more than the preſent diſpoſal of the writer's time will permit; yet the mention of a few of their leading traits is at leaſt due to the merits and the memory of ſo excellent an artiſt. Freedom, boldneſs, and an happy imitation of the wild forms of inartificial Nature are among their diſtinguiſhing features. The drawing of his trees in particular; his diſcrimination of their ſeveral characters; his thorough knowledge of their various modes of growth, combined with a mode of expreſſion ariſing ſpontaneouſly out of his ſubject, have perhaps never been excelled. Among the rude and artleſs landſcapes of the South-ſea iſlands, or the wild and luxuriant forms of lake and foreſt ſcenery, his etching-tool and his fancy would revel delighted, and communicate to every cultivated eye a correſponding pleaſure. With ſuch claims to ſuperior art, men of diſcernment will lament that it was the lot of Pouncy to be obliged to trammel his talents, and employ a conſiderable portion of his time in engraving *fac-ſimiles* from the pages of Doomſday-book; in tracing the Spaniſh lines before Gibraltar; and on other ſubjects that required merely care, and the exerciſe of a certain regular mathematical ability he did not naturally poſſeſs. On the whole, it may be ſaid of his works, which are chiefly after Farington, Hearne, Smith, and Wilſon, that they will continue to be admired wherever legitimate art and true taſte are not obſcured by the falſe glitter ſo much the faſhion of the day; and that, in private life, the hoſpitality of his manners, the compaſs of his knowledge, the liberality of his ſentiments, and the goodneſs of his heart, will long be remembered with regret by thoſe who had the happineſs of being intimately known to him.

L.

THE

PHILOSOPHICAL MAGAZINE.

SEPTEMBER 1799.

I. *On the gradual Changes in Temperature and Soil which take place in different Climates, with an Enquiry into the Cauſe of thoſe Changes. By the Abbé* MANN *.

VARIOUS authors, both ancient and modern, have written on the ſubject of this Diſſertation, but merely in a curſory manner; one only, Dr. Hugh Williamſon, an American phyſician, has made it an object of particular attention; but what he has ſaid relates only to North America, and is comprehended in a very ſhort paper publiſhed in the Philoſophical Tranſactions of Philadelphia for 1777. It has long appeared to me intereſting enough to require farther and more accurate examination; but before I enter into any reſearch reſpecting the cauſes of thoſe changes of temperature and ſoil, obſerved in different countries during a long ſeries of ages, it ſeems to be neceſſary firſt to prove, by authentic teſtimony, that theſe changes have actually taken place. This Diſſertation divides itſelf naturally into two parts. In the firſt I ſhall collect all the information of an-

* From the *Tranſactions of the Electoral Academy of Sciences at Manheim*, Vol. VI.

cient authors I have been able to find on the ſtate of the temperature and ſoil in their time in Gaul, Germany, Pannonia, Thrace, Mœſia, Dacia, and the European part of Scythia. As moſt of theſe writers, however, when they ſpeak of the climate of thoſe countries, expreſs themſelves more or leſs in an almoſt unintelligible manner, and nearly in the ſame words, it would be ſuperfluous to quote, at full length, all the paſſages I have collected on the ſubject. I ſhall therefore content myſelf with giving, in regular order, the ſubſtance of all the circumſtances they have communicated to us in regard to the climate of the above countries; and in the ſecond part I ſhall briefly enquire into the phyſical cauſes which, in the courſe of ſeveral centuries, may have gradually contributed to produce theſe changes.

I. *Proofs of the Change of Temperature and Soil in the Climates of Europe.*

We are told by Herodotus, more than once, that in the European part of Scythia, on the Palus Meotis, the winter continued eight months every year with almoſt inſupportable ſeverity; and that the countries farther towards the north were on that account uninhabitable: he adds, that the other four months, called the ſummer, were alſo exceedingly cold. Now this country lies between the 44th and 50th degree of north latitude, and we know at preſent that nothing of the like kind has taken place there for a long time. Cæſar, Virgil, Diodorus Siculus, Ovid, Strabo, Pomponius Mela, Seneca, Petronius, Pliny the naturaliſt, Statius, Herodian, and Juſtin, all ſpeak in the ſame manner of the inſupportable cold of the winter in different parts lying in the ſame latitude of from 44 to 50 degrees between Gaul and the Euxine Sea. They quote ſo many and ſo evident effects of this winter cold, that it is not poſſible to aſcribe their deſcriptions to the manner of life they were accuſtomed to in the warmer diſtricts of Italy, Greece, or Aſia.

The deſcriptions which they unanimouſly give, would at preſent

preſent ſuit thoſe countries which lie between 56 degrees of latitude and the polar circle; and in ſome reſpects they ſeem to exceed the cold of the winter in Sweden and Norway. In order to ſee realiſed at preſent the deſcriptions which the ancients have given of the climate of the middle part of Europe in their time, it would be neceſſary to viſit Lapland, Siberia, and thoſe regions of America lying to the north of Hudſon's Bay, where the ſtate of the climate is the ſame as that 2000 years ago on the banks of the Rhine and the Danube, the Palus Meotis, the Dnieper, and the Don.

The firſt effect, uniformly mentioned by the ancients, of the extraordinary cold of the winter in that whole part of Europe between the 44th and 50th degree of latitude is, that all the ſeas, lakes and rivers contained in thoſe diſtricts were continually frozen in winter, ſo that armies of barbarians, Scythians and Sarmatians, in order that they might plunder the more ſouthern countries, paſſed with their horſes, waggons and baggage over the ice, which they beſtrewed with ſtraw to prevent their ſliding. This is expreſsly aſſerted by Herodotus, Virgil, Ovid, and Strabo, of the European part of Scythia, Dacia, and Thrace, all countries which lay in a northern and weſtern direction from the Palus Meotis and the Euxine Sea. The ſame thing is aſſerted by Diodorus Siculus, Seneca, Pliny the younger, Florus, Herodian, Ammianus Marcellinus, Fernandes the Goth, and Xiphilinus the abridger of Dio Caſſius, in regard to the rivers and lakes of Pannonia, Germany, and Gaul. They mark the times when theſe armies paſſed the ice, and the wars which they then carried on; ſo that no doubt can be entertained in regard to teſtimony ſo unanimous and authentic. Herodotus ſays, that the Scythians in this manner over-ran, during winter, all the neighbouring countries as far as India; and we are told by Strabo, that Neoptolemus, the general of Mithridates, beat the barbarians in winter with an army of cavalry, at a place which in ſummer had been the ſcene of a naval battle. In the Treatiſe on Rivers,

aſcribed to Plutarch, it is ſaid, the Thermodon, a Scythian river, froze even in ſummer; a circumſtance which never happens at preſent in regard to the rivers of Siberia, Lapland, and Greenland. Ovid tells us, that he himſelf paſſed over the Pontus Euxinus on the ice. People, adds he, will ſcarcely believe me:

——————— Sed cum ſint præmia falſi
Nulla, ratam teſtis debet habere fidem.

Plutarch ſays, that the preſſure of this enormous maſs of ice againſt the ſides of ſhips frozen into it, cruſhed them to pieces; and he mentions the inſtance of a Roman ſhip which had experienced that fate in the Danube. Strabo and Virgil ſpeak of braſs veſſels burſting by the expanſive force of the ice; and we are aſſured by Virgil and Ovid, that the people in Thrace and on the Danube cut the wine with axes, and diſtributed it in ſolid portions. They add, likewiſe, that men's hair and beards were often covered with ice.

Stiriaque impexis indurent horrida barbis. VIRGIL.
Sæpe ſonant moti glacie pendente capilli,
Et nitet inducto candida barba gelu. OVID.

If we compare this deſcription with the preſent ſtate of France, Germany, Hungary, Romania, Tranſylvania, Wallachia, Moldavia, Bulgaria, Leſſer Tartary, Podolia, and the Ukraine, it will be found that the preſent temperature of theſe countries has no reſemblance to what it was two thouſand years ago: the effects produced there every winter ſcarcely take place now once in a century, and when they occur they are conſidered as extraordinary phenomena.

From ice I ſhall proceed to ſnow. Herodotus, Pomponius Mela, and Pliny the elder, ſpeak of the European part of Scythia as if its atmoſphere was continually filled with ſnow and fogs, which prevented the view of the neareſt objects, and obſcured the light of the day. We are told by Herodotus, that this immenſe load of ſnow, when it fell, made the air appear as if filled with feathers; and that, for this

this reaſon, the country was called *Pterophoros*. Diodorus Siculus ſpeaks of Celto-Scythia as covered with ſnow in the winter time; and the ſame thing is aſſerted by Florus and Petronius. Virgil, ſpeaking of Thrace and the countries on both ſides of the Danube, ſays, that a continual winter prevailed in them; and that the ſnow lay upon the ground ſometimes to the depth of ſeven ells.

> Sic jacet aggeribus niveis informis, et alto
> Terra gelu latè, ſeptemque aſſurgit in ulnas,
> Semper hyems, ſemper ſpirantes frigora cauri.

The picture which Ovid gives of the ſnow at Tomi (in the lat. of $44\frac{1}{2}$) is no leſs horrid, as he tells us that it continued two years without being melted by the ſun or rain:

> Nix jacet et jactam nec ſol pluviæve reſolvunt;
> Et ſolet in multis bima manere locis.

In regard to other meteorological phenomena in the European part of Scythia and Celto-Scythia in the time of Herodotus and the following century, this hiſtorian ſays, that it ſeldom rained in the winter, becauſe at that period it ſeldom ceaſed to ſnow; and that, on the other hand, when the weather in ſummer was dry and fair in Greece and Leſſer Aſia, it never ceaſed to rain in the country of the Celto-Scythians: that during this ſeaſon the heavens were always overcaſt with clouds, and that thunder, even in ſummer, was very uncommon; that when it happened in winter, it was conſidered as a wonder, and that, in thoſe ſeaſons when it took place, earthquakes were obſerved alſo. This laſt circumſtance is indeed worthy of attention, as it ſerves to confirm my conjectures reſpecting the theory of the earth.

Diodorus Siculus, Tacitus, and Ovid, when they ſpeak of Gaul, Germany, and Thrace, take notice of the prodigious force of the wind which prevailed in theſe countries in their time and during the preceding centuries. Theſe winds raiſed even ſtones and men from the earth; carried away the roofs of houſes; tore up trees by the roots, and overturned turrets

and houſes. Such effects of the wind are indeed obſerved at preſent, particularly in the countries on the Northern Sea and the Bay of Biſcay, but ſeldom in thoſe parts of the Continent ſpoken of by the ancients.

Varro, Diodorus Siculus, Ovid, Pomponius Mela, Seneca, Petronius, Pliny the elder, Tacitus, Appian, Dio Caſſius, and Herodian, all agree in ſaying that the ſeverity of the climate and weather which in their time prevailed in Gaul, Germany, Pannonia, Thrace, Mœſia, and Dacia, would hardly admit either vines, olives, or any kind of fruit-trees; and that, in cultivating them, it was neceſſary to cover them with dung or with earth to preſerve them throughout the winter. Tacitus, however, adds, that theſe countries produced, in abundance, various kinds of grain, where the people gave themſelves the trouble to improve and manure their fields by means of marl or chalk, which deſtroyed the cold and the moiſture. This circumſtance is expreſsly remarked by Varro: *Agros ſtercorarent candida foſſitia creta.* He afterwards adds, that in theſe countries there was neither rock ſalt nor ſea ſalt: the preparation of the latter required a ſtronger heat than exiſted in thoſe climates *. The inhabitants ſupplied the want of ſalt by ſaline aſhes from certain kinds of wood burnt for that purpoſe, and which were drenched with ſalt water. Pliny and Tacitus give the ſame account.

It is obſerved by Herodotus, Strabo, and Tacitus, that the oxen in the European part of Scythia and the country of the Celto-Scythians had no horns, or horns exceedingly ſmall; which they aſcribed to the ſeverity of the cold and the climate. Herodotus confirms this idea in a negative

* This, indeed, proves nothing in regard to the climate; but it ſhews the want of knowledge and induſtry. The paſſage in Varro *De Re Ruſtica*, i. 7. is as follows: *Ubi ſalem nec foſſitium nec maritimum haberent; ſed ex quibuſdam lignis carbonibus ſalſis pro eo uterentur.* It is probable that they boiled their ſalt, as was done in former times in ſome parts of Europe; that is, poured the ſaline liquor over glowing pieces of wood, and collected the ſalt which adhered to the charcoal. *G.*

manner

manner by the teſtimony of Homer, who ſays in the Odyſſey, that in Lybia the lambs had horns from their birth, owing to the great heat. Strabo, as a proof of the great cold which prevailed in the country now called the Ukraine, obſerves that it produced n . aff s; animals, ſays he, which cannot endure the cold: and he adds, that the horſes there were extremely ſmall. But nothing, indeed, is more aſtoniſhing than the teſtimony of Pauſanias, who ſays expre'sly, that in Thrace there were in his time bears and wild ſwine of a white colour. Such animals at preſent are found only in the remoteſt parts of the north, on the other ſide of the polar circle. We are told by Virgil, Ovid, and Pomponius Mela, that the inhabitants of the European part of Scythia and Thrace lived, during the whole winter, under the earth (as the Laplanders do at preſent); that they burnt large logs of wood to keep themſelves warm; that they never went abroad without being wrapped up in ſkins; and that they left no part of the body uncovered but the mouth and eyes. Pomponius Mela ſays, *Specus aut ſuffoſſa habitant, totum braccati corpus, et niſi quæ vident etiam ora veſtiti.*

I think it of importance to point out here the boundaries of thoſe countries towards the north, which the ancients conſidered as deſolate and uninhabitable on account of the great intenſity of the cold. Herodotus ſays, that beyond the Melanchlini, a Sarmatian people, ſo called from their black hair, there were only lakes, moraſſes, and uninhabitable diſtricts as far as was then known; and we learn from Ovid that on the other ſide of the Cimmerian Boſphorus, the Tanais, and the Scythian moraſſes, a cold prevailed which rendered the country uninhabitable.

> Boſp orus et T ..ais ſuperant Scythicæque paludes;
> Ulterius nihil eſt, niſi non habitabile f gus.

This is expreſsly confirmed by geographers and hiſtorians. Strabo repeats, ſeveral times, that all the lands towards the north of the tribes who lived on the banks of the Tanais

and the Boryſthenes were uninhabitable on account of the ſeverity of the cold which prevailed in them. But all that has been traced out of the banks, and even the origin of this river, does not lie beyond the 55th degree of latitude; conſequently is on the ſame parallel with the northern part of England and Germany, the middle of Lithuania, and the middle of Ruſſia. Between theſe two rivers Strabo places alſo the Rhoxolani, who in general are conſidered as the anceſtors of the Ruſſians; and he adds, that all the diſtricts farther north were uninhabitable on account of the cold. In another place he ſays, that all the northern part of Britain was very thinly peopled on account of the cold, and that he believed all the countries lying beyond it to be uninhabited. Now no part of Great Britain extends beyond the 60th degree of north latitude; conſequently that parallel includes all Norway, almoſt the whole of Sweden, and the half of Ruſſia. Theſe countries, therefore, in the time of Strabo, that is, about the period of Auguſtus, were conſidered as uninhabited. The ancients, in general, ſpeak of all the lands which lay beyond the 55th degree of north latitude as filled with lakes, moraſſes, ice, ſnow, and fogs, almoſt like thoſe countries to the north of Hudſon's Bay.

Theſe, in my opinion, are ſufficient and unqueſtionable proofs of the exceſſive ſeverity which prevailed 2000 years ago in the climate of thoſe countries of Europe lying between the latitude of 44° and 50° north latitude, and fully eſtabliſh the difference between the ſtate of their temperature in thoſe periods and what it is at preſent. The more northern lands, which the ancients, on account of their unſupportable cold, conſidered as uninhabitable; Iceland, Norway, Lapland, and the northern part of Ruſſia and Siberia, are habitable, and inhabited at preſent, as is well known, though exceedingly cold. The ancients alſo ſpeak of effects produced by the cold of winter in Italy, Greece, Leſſer Aſia, &c. which at preſent are certainly unknown. The ſoil of the latter countries, as well as that of the ancient Aſſyria, Chaldea, Paleſtine,

Paleſtine, the Roman part of Africa, and Spain, is at preſent remarkably ſtony, and burnt up with heat. We, however, know, that Spain in particular, about 1800 years ago, was exceedingly rich and fruitful, and abounded with all ſorts of proviſions, which are no longer to be found in it *. It appears to me unneceſſary to produce more proofs, as the change of the ſoil and fertility in all the countries bordering on the Mediterranean Sea, and which formed the richeſt and moſt beautiful part of the Roman empire, is admitted as a certain fact by all thoſe who have ſpoken of their former and preſent ſtate.

It is therefore beyond a doubt, that the ſoil and temperature of all the lands from Spain to India, and from the ridge of Mount Atlas to Lapland and the remote parts of the north, have in the courſe of ages, ſince the period of the oldeſt hiſtorical monuments ſtill extant to the preſent time, been gradually ſubjected to a complete change, from the utmoſt degree of moiſture and cold, to a great degree of dryneſs and warmth. An effect ſo continued and uniform muſt have ſome cauſe, which is equally ſo itſelf.

Dr. Williamſon aſſerts, that the climate of America is becoming continually milder; and he confirms it by a number of facts. This effect is directly contrary to the hypotheſis of a celebrated naturaliſt reſpecting the theory of the earth and the planets, who aſſerts, that they have been continually loſing warmth ſince they were firſt in a ſtate of fuſion, and are becoming always colder; ſo that they will at length be incapable of keeping alive any animal or vegetable production †. All hiſtorical and phyſical monuments, however, prove the contrary.

* The diſtricts in the neighbourhood of Toledo are deſtitute of trees, on which account the heat in ſummer is unſupportable, and wood in winter exceedingly dear. When Martial wrote the following lines, the country muſt certainly have been in a very different ſtate:

Æſias ſerenus aureo franges Tago
Obſcurus umbris arborum.

† This was the opinion of Buffon. Edit.

It

It is not merely in modern times, and ſince the improvement of natural philoſophy, that this change of temperature and ſoil has been remarked. A great number of places, well known and deſcribed by the ancients, in Paleſtine, Syria, Leſſer Aſia, Greece, Italy, Spain, and Barbary, exhibit proofs of the changes which have taken place in the ſoil and temperature in the courſe of time. Every one knows their preſent dry and barren ſtate, which ſeems to be paſt remedy. It is ſo contrary to that in which they were formerly, according to all the deſcriptions of them left us by Greek and Roman authors, that it is impoſſible for us to aſcribe this difference merely to the inclination of the ancients for exaggeration *: the clear and preciſe facts, which various celebrated authors have mentioned reſpecting them, will not allow of ſo abſurd a ſuppoſition. Ovid ſays that, in his time, Lower Mœſia, to which he was baniſhed, produced neither vines nor fruit-trees.

Nam procul à Getico littore vitis,
Nam procul à Geticis finibus arbor abeſt.

Strabo, who was a few years later than Ovid, ſpeaking of vine plants in the Thracian Boſphorus, ſays, that in winter it was neceſſary to bury them under the earth in order to preſerve them. Not long after, it was obſerved by Pomponius Mela and Pliny the elder, in ſpeaking of Thrace, that there were ſcarcely any fruit-trees in that country, and that in winter it was neceſſary to cover them with dung. Mela adds, that the vines often grew there, but that the grapes never ripened †. Columella is the firſt author who ſpeaks of vines in Gaul; and he ſays that the Sabines and the Romans in the preceding century had procured, amidſt the deva-ſtation of war, more abundant crops than had been procured in his time during a ſtate of perfect peace. But no-

* Voltaire pays this compliment to the authors of the Bible in regard to Paleſtine.

† Vitem frequentius tolerat, ſed nec ejus quidem fructus maturat ac mitigat.

thing

thing in this reſpect is more ſtriking than what is obſerved by Columella in regard to the changes of climate. "I find," ſays he, "that it is the opinion of many reſpectable authors that the quality and ſtate of the atmoſphere become changed in the courſe of a long ſeries of ages: for Saſerna, in that work which he has left on agriculture, infers that the ſtate of the atmoſphere is changed, becauſe certain diſtricts, which formerly were incapable of producing vines or olives on account of the continual ſeverity of the winter, now yield abundant vintages and plenty of oil by the climate having become milder and warmer*." But it is now time that I ſhould proceed to an inquiry into the cauſes that produce theſe changes, the effects of which I flatter myſelf I ſhall be able to prove.

[To be concluded in next Number.]

II. *Obſervations on the Vibration Nodes of Muſical Strings.* *By* J. G. Voigt *of Halle*†.

EXPER. I. Divide AB, the ſtring of a monochord, into any number of equal parts, for example four, by the points CDE, and place a moveable bridge at E; put on the points C, D of the ſtring, and any others at pleaſure, light bodies, ſuch as ſmall bits of paper, and draw a violin bow, rubbed with roſin, over the part EA; you will hear the tone correſponding to the part EA, which is to the tone of the whole ſtring AB as 4 : 1; and all the bits of paper, except thoſe lying on the points

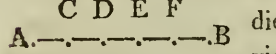
C D E
A.—.—.—.—.B

* Multos enim memorabiles auctores comperi perſuaſum habere, longo ævi ſitu qualitatem cœli ſtatumque mutari ———. Nam (Saſerna) eo libro quem de agriculturâ ſcriptum reliquit, mutatum cœli ſtatum ſic colligit, quod, quæ regiones antea propter hiemis aſſiduam violentiam nullam ſtirpem vitis aut oleæ depoſitam cuſtodire potuerint, nunc mitigato jam et intepeſcente priſtino frigore largiſſimis olivitatibus, liberique vindemiis exuberent. *De Re Ruſtica*, Lib. i. cap. 1.

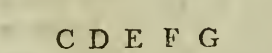
† From Gren's *Journal der Phyſik*, Vol. II. part 3.

C and D, will, by the vibration of the ſtring, be thrown from it. The points C and D are called vibration nodes. In this, and all the other experiments of this kind, the point where the bridge ſtands is alſo a vibration node.

II. Divide the ſtring AB into a number of equal parts at pleaſure, for example five; cut off, by removing the bridge to E, two of theſe parts (this number 2 and the other 5 muſt have 1 for a common diviſor); place upon the points of diviſion C, D, F, and any others of the ſtring taken at pleaſure, light bodies, ſuch as bits of paper; draw the violin bow over the part EA, and all the bits of paper except thoſe on C and D will then be thrown off, and you will hear a tone which is to the tone of the whole ſtring as 5 : 2, and which correſponds to the tone of the part EA.

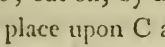


III. Divide a ſtring AB into any number of equal parts, for example ſix, by the points C, D, E, F, G; cut off as before, by removing the bridge to F, two parts (this number 2, and 6 the number of the parts of the whole ſtring, muſt have a greater common diviſor than 1); place upon the other four points of diviſion C, D, E, G, and on any others of the ſtring taken at pleaſure, light bodies, ſuch as bits of paper; and all theſe, except that at D, will be thrown down by rubbing the bow againſt FB, the part cut off by the bridge; you will alſo hear a tone correſponding to the part FB, which is to the tone of the whole ſtring as 6 : 2 or 3 : 1.



IV. If you place upon the ſtring, without cutting off any part of it by the bridge, different bits of paper in points taken at pleaſure, and rub with the bow ſo as to make the whole ſtring ſound, all the bits of paper will be thrown from it. This experiment will give the ſame reſult when you cut off in the middle the part of the ſtring which actually ſounds; for example, you may vary the ſecond experiment thus:—

V. Divide the ſtring AB by the points C, D, E, F, into five equal parts; cut off, by means of two moveable bridges, the part DE; place upon C and F, and other points of the ſtring AB, ſmall bits of paper: rub the bow againſt ED; all the bits of paper will be thrown off except thoſe in C and F, and you will hear the tone corresponding to DE, which is to the tone of the whole ſtring as 5 : 1.



From theſe few experiments, the following laws reſpecting vibration nodes may be deduced :—

1. The part of the ſtring apparently at reſt is not perfectly ſo, but only its vibration nodes.

2. The original vibrating part of the ſtring, which is brought into immediate vibration by rubbing with the violin bow, has no vibration nodes; and therefore no ſtring on the violin, violoncello, harp, or harpſichord, can have any. All the vibration nodes on theſe inſtruments lie behind the bridge.

3. For vibration nodes to be poſſible, a part of the ſtring muſt be apparently at reſt; conſequently, the number which expreſſes the height of the tone emitted, as compared with the tone of the whole ſtring = 1, muſt be greater than one, and muſt therefore be expreſſed by an improper fraction.

4. In order to determine the number of the vibration nodes of a ſtring for the tone $\frac{a}{b}$, where, as before ſhewn, a muſt be greater than b, we need only reduce the fraction $\frac{a}{b}$, which expreſſes the proportional height of the tone, to its loweſt terms $\frac{p}{q}$, and ſubtract the ſmaller number q from the greater p: the difference $p-q$ will be the number of the vibration nodes. This law follows very naturally from the preceding experiments.

When the height of the tone to be produced is to the tone

of

of the whole ſtring as $\frac{a}{b}$, $\frac{b}{a}$ parts of the ſtring muſt be rubbed with the bow in order to produce that tone, that is, the ſtring is divided into a parts, and b parts muſt be cut off and rubbed with the bow; therefore $a-b$ are parts of the ſtring, or $\frac{a-b}{a}$ of the whole ſtring apparently at reſt, the extreme points of which are capable of producing vibration nodes; and when $\frac{b}{a}$ is brought to its loweſt expreſſion, it gives $a-b$ vibration nodes. If $\frac{b}{a}$ be not in its loweſt terms, let its loweſt terms be $\frac{q}{p}$; ſo that $\frac{b}{a} = \frac{q}{p}$, and when e is the greateſt common diviſor of a and b, a will be $= ep$, and $b = eq$; therefore $a-b = e(p-q)$. Now, if it ſhould be required to apply this law to $\frac{b}{a}$, the number of the vibration nodes $a-b$ muſt be $= e(p-q)$; but if applied to $\frac{q}{p}$, as above demonſtrated, the number of the vibration nodes will be $p-q$; therefore $e(p-q) = p-q$, which can no otherwiſe be true than when e is $= 1$, that is, $\frac{b}{a}$ or $\frac{a}{b}$ muſt be expreſſed in its loweſt terms.

5. As the members of two fractions not of the ſame value may have the ſame difference as $\frac{3}{7}$ and $\frac{1}{5}$, the ſame number of vibration nodes may exiſt where the tones are different, and therefore each tone has not its own peculiar number of vibration nodes.

6. Vibration nodes are only poſſible where the tones have a certain ratio to the fundamental tone.

It muſt not, however, be expected, that the experiment can be made, for example, with a ſtring 26 inches in length, in ſuch a manner that you can divide it into 40 or 50 parts, and rub one of them with the bow; for in this caſe the vibration nodes, or points at reſt, are at ſo little diſtance from each

each other that a piece of paper will cover more than one vibration node, and will be thrown off by rubbing with the bow, though they ought to remain; or the vibration will be too weak, and not be ſufficient to throw off the bits of paper which ought to fall.

III. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth. By* M. De Saussure.

[Continued from page 265.]

CHAP. XIX.

Reſearches to be made in regard to Earthquakes.

1. THE hiſtorical part: the greatneſs, extent, and chronology of their ravages in different countries.

2. Does it appear that ſome countries are more expoſed to them than others; are there ſome abſolutely exempted; and how far is this connected with the local ſituation of the country?

3. To obſerve the extent, duration, and direction of the vibrations experienced by the earth when it ſhakes.

4. Are there any meteorological phenomena that announce or accompany earthquakes; ſuch as extraordinary heat, calms, ſtorms, movements of the barometer, electricity, vapours diſperſed throughout the atmoſphere, paleneſs or peculiar colour of the ſun and ſtars?

5. Other phenomena; ſuch as ſubterranean noiſe, extraordinary movement of the ſea, the water of ſprings increaſed or dried up, any particular ſmell, ſymptoms of terror among domeſtic animals.

6. Are there any indications that ſome earthquakes may have been the effects of electricity, and that ſuch convulſions might be prevented by conductors?

7. Are there not ſome alſo which immediately depend on ſubterranean

ſubterranean fires, and which are preceded by or accompanied with volcanic eruptions?

8. Are there any which exhibit indications of the effects of water converted into ſteam?

9. To aſcertain the ſimultaneous or at leaſt aſtoniſhing rapidity of the effects of earthquakes at very great diſtances.

10. Are there any inſtances that, during the moment of an earthquake, ſome pretty conſiderable tract of land, or a mountain, has been raiſed to a great height above its former level, and has afterwards remained in a ſtate of elevation?

11. Are there dry fogs, ſuch as that of 1783, which may be conſidered as vapours, that have iſſued from the earth by the action of ſhocks or concuſſions.

CHAP. XX.

Obſervations to be made on Mines of Metal, Coal, and Salt.

1. The hiſtorical part: the epoch of the diſcovery of a mine; of its being firſt worked; the expence and net produce at different periods. If there ever was, or ſtill is, a grant of it, and on what conditions.

1. A. In regard to the phyſical part, care muſt be taken to examine whether the ore be in veins or ſtrata; that is to ſay, whether it interſects the ſtrata of the mountain, or be parallel to them.

2. In mines which conſiſt of veins, the dimenſions, thickneſs, and length of the veins are to be examined; their inclination in regard to the horizon, and their direction in regard to the cardinal points. The miners call this direction the *bours*.

3. The metal it contains; the mineraliſing ſubſtance, and the kind of mineral which thence reſults.

4. The matrix, or non-metallic foſſil, found mixed with the ore.

5. The nature of the ſoil at the bottom, or that part of the mountain on which the vein reſts; nature of the covering, or part of the mountain immediately above it.

6. Nature

6. Nature of the covering of the veins, or thoſe parts of the vein next to the ſubſtance of the mountain.

7. Nature of the *druſes*, or cryſtalliſed *geodes* contained in the vein.

7. A. The form, dimenſions, and nature of the mountain which contains the vein.

8. Situation of the vein in regard to the ſtrata of the mountain; under what angle it interſects them.

9. Its ſituation in regard to the exterior part of the mountain; whether it be parallel to the external inclination of the mountain, or whether that inclination be in a contrary direction.

10. The progreſs of the vein: whether it be ſubject to change its direction or ſituation, and according to what laws; if there are any indications that precede theſe changes; any corners, vacuities, or fiſſures, which interrupt the courſe of the vein; and how it is found after having been loſt: ſituation and diſtance of the place where it is richeſt.

11. Lateral veins or ramifications of the principal vein; veins by which it is accompanied, or which run parallel to it.

12. To verify Werner's theory in regard to veins, the fundamental principles of which are as follows:—

A. That the ſpaces occupied by veins have been originally empty crevices or fiſſures.

B. That theſe fiſſures have been afterwards filled from the bottom upwards, at a time when the ſea ſtill covered the mountains; and by the precipitation or cryſtalliſation of the ſubſtances which were before diſſolved in the waters of the ſea.

C. That of two veins croſſing each other, the moſt modern is that which interſects the other.

D. That of two veins, one of which ſtops and diverts the courſe of the other, the moſt modern is the latter.

E. That, in the ſame vein, the parts neareſt to the ſides of the ſurrounding ſubſtance, the *ſalbande* for inſtance, are the moſt ancient; thoſe in the middle the moſt modern; and the intermediate ones of a mean antiquity.

F. Alſo that, in the ſame vein, the loweſt parts are the moſt ancient.

G. That in ſome veins there are found rolled pebbles; in others the remains of organiſed bodies, ſhells, and wood; and in others, of coal, ſtones, and ſea-ſalt.

H. That one may aſſign the relative age of the formation of different minerals; for example, that tin mines may be ſaid to be of the moſt ancient formation; then thoſe of uranite, biſmuth, &c.

The greater part of the following queſtions will furniſh confirmations of this theory, or objections againſt it, according to the ſolution given of them:

13. Is it true that there are mountains, or portions of mountains, ſo pierced with cotemporary veins that they could not have ſupported themſelves, had not the ſubſtance with which they are filled been created at the ſame time as the mountain itſelf? I have uſed the expreſſion cotemporary, becauſe, if we can ſuppoſe that the fiſſures filled by theſe veins were formed in ſucceſſion, the objection which this fact would preſent to the theory of Werner would be by theſe means reſolved.

13. A. I muſt here repeat the 10th queſtion of Chap. II. How can it be conceived that all the metals and ſubſtances found in a vein ſhould have been diſſolved by the water of the ſea*?

14. Is it true that there are in Derbyſhire vertical veins of lead interſected ſeveral times by horizontal ſtrata of amygdaloides or loadſtone?

15. Are there found, in the neighbourhood of veins, ſtrata of the ſame mineral contained in theſe veins, and which ſeem to have been depoſited at the ſame time when the depoſits of the ſea filled the fiſſures occupied by theſe veins?

16. Is it well aſcertained that there are certain metals and certain kinds of ore found only in certain kinds of moun-

* Or in the waters of the great ocean, which are ſuppoſed to have covered the whole globe of the earth. C.

tains?

tains? And, if this circumſtance be true, does it ariſe from the relative age of theſe minerals and mountains, or from the ſubſtance of the mountains favouring the precipitation of one kind of mineral more than that of another?

17. Is it true, as M. de Trebra ſays, that the richeſt veins, and the richeſt points of any vein, are found in the vertical line which correſponds with the loweſt part of the reſervoirs of the rain water, and never in the peaks and moſt elevated ridges? And, if this be well aſcertained, would it not prove that the veins had an origin poſterior to the grand revolutions which have given to the ſurface of our globe its preſent form, and that the metals have been depoſited in them by the meteoric waters?

18. Is it true alſo that the richeſt mines are found in mountains, the declivities of which are not ſteep*?

19. Are there inſtances of veins, entirely exhauſted, being again filled up with ore?

20. Does the production of metals depend on the influence of the ſun and climate? Are they more frequently found near the eaſtern or ſouthern, than the weſtern or northern faces of mountains?

21. Can we generaliſe the obſervation made in Siberia, Tranſylvania, at Mount Roſe, and in other places, that in gold mines the veins are richer near the ſurface of mountains than at a greater depth.

21. A. Is it generally true, that the veins are richer at their points of interſection than in any other place?

22. Is the inclination of veins ſeen more frequently contrary, than parallel to, the adjacent face of the mountain?

23. Does it ſometimes happen that the rock which forms the ſides (*neben-geſtein*) of the vein is as rich and even richer in metal than the vein itſelf; and would it thence

* As the Saxon authors generally ſay; becauſe the fact is true among them and in ſome other countries, while the caſe is not ſo elſewhere, and particularly in the Pyrenees. C.

follow, that the metal arrives at the vein by filtering itſelf through theſe ſides?

24. Is it true that, in mountains of granite, the grain of the granite is finer and the ſtone more tender in the neighbourhood of a vein?

25. Are there obſerved in any mine proofs that ſubterranean fires have contributed to its formation by ſubliming the metallic ſubſtances, or by melting them? In a word, are there ſeen there any traces of the action of fire?

26. In the greater part of mines do we not, on the contrary, obſerve proofs of the action of water in the ſituation of minerals and of their matrices; in their *druſes* (groups of cryſtals), and in the ſtate, form and nature of their cryſtalliſation?

27. Does there prevail, at the bottom of mines, a heat ſuperior to the mean temperature of the earth? And if ſuch a heat exiſts in any mine, may it not be explained by that produced by the lamps; by the miners themſelves; by ſome accumulations of pyrites, or ſome local reſervoirs of water, without having recourſe to a general cauſe or central fire?

28. Is it certain that, in general, veins decreaſe in thickneſs in proportion as they proceed to a greater depth, and terminate in ſuch a manner that the fiſſures which contain them are cloſed at the bottom? Were this fact eſtabliſhed, would it deſtroy the poſſibility of ſublimations ariſing from the interior parts of the earth *?

29. In mines which proceed by ſtrata, to obſerve their nature, extent, thickneſs, inclination, and depth; their interruption by the veins that interſect them; their alternate ſwellings and conſtrictions, as well as the augmentation and diminution of their richneſs, and the ſigns which precede theſe changes.

* 28. A. Do there exiſt veins of from ten to twenty fathoms and more in thickneſs? or have not metalliferous banks or fiſſures between two different kinds of ſtone been taken for veins? C.

30. Whe-

30. Whether it be rare to find, under the form of ſtrata, other metallic mines than thoſe of copper, iron, lead, calamine, and manganeſe.

31. Whether the mines in ſtrata are generally poor near the ſurface of the mountain, and become richer the deeper they proceed.

31. A. Whether mines, where the metal is found in lumps or in a maſs (*ſtockwerke*), ought to be claſſed among thoſe in veins or thoſe in ſtrata * ?

32. In coal mines to obſerve the nature of the coal; more or leſs compact; more or leſs rich in bitumen; more or leſs mixed with argil or pyrites.

33. To examine, in the coal, the traces of their origin; whether they have been formed of wood, turf, or marine plants †.

34. To obſerve whether there are found the remains of marine or terreſtrial animals.

35. The progreſs of the ſtrata: whether it be true that they often begin by deſcending in order to become horizontal, and afterwards to re-aſcend; and that they are thickeſt in the horizontal part, and give coal of a better quality ‡.

* 31. B. To obſerve alſo a third poſition of the ore, or ore found in the tranſitions (*ſtein-ſcheidung*); that is to ſay, between two kinds of ſtone of a very different nature; as between argillaceous ſchiſt and calcareous ſtone, between the ſame ſchiſt and compound rocks, &c. Not to confound this poſition of ore with real veins, nor with metalliferous banks, ore in ſtrata, and the *ſtockwerke*. C.

† 33. A. To diſtinguiſh carefully real coal from jet or foſſil coal (the *brawn-koble* of the Germans), and from coal earth, as well as from that ſubſtance known by the Germans under the name of *blend-koble*. C.

33. B. To examine whether there is not found ſometimes in calcareous ſoil, fat, gelatinous coal; or whether there is never found but dry, friable coal. C.

‡ 35. A. To aſcertain whether there exiſts foſſil coal in veins, as is ſaid to be the caſe at Wehrau in Upper Luſatia. C.

36. Whether there are ſeveral ſtrata, one above the other, with banks or other foſſils interpoſed. The quality and relation of theſe ſtrata.

37. The nature and thickneſs of the ſtrata of the earth or ſtones under which the coal mine is found; the impreſſions and other veſtiges of organiſed bodies found in theſe ſtrata.

37. A. How can thoſe who aſcribe the origin of coal to foreſts buried in the earth, explain the very thin ſtrata of that foſſil contained between banks of calcareous ſtones, and which are repeated at different heights in the ſame mountain? Does not this obſervation ſhew that there are coal which have originated alſo from fuci, algæ, and other marine plants?

37. B. Ought we to ſuppoſe that all coals have been in a ſtate of ſolution? What is the agent which diſſolved them, and which may be called the mineraliſer?

38. Though mines of rock ſalt are commonly found in ſtrata, yet M. Fichtel affirms, that there are found in Tranſylvania enormous maſſes of pure ſalt, compact, and without any appearance of foreign bodies. Theſe he conſiders as of very ancient formation, and diſtinguiſhes them from thoſe which are in ſtrata between beds of argil and free-ſtone mixed with ſhells. Theſe important facts deſerve to be thoroughly examined.

39. To aſcertain the truth of an aſſertion made by the ſame geologiſt, that theſe maſſes of ſalt are ſurrounded by ancient volcanoes; and to determine whether we ought to believe with him, that this ſalt has been cryſtalliſed by the heat of thoſe volcanoes which evaporated the water that held them in ſolution.

40. To examine, in the laſt place, whether any of theſe maſſes of ſalt appear to have been raiſed up by ſubterranean fires to a height greater than that at which they were at the time of their formation.

41. To examine the reaſon of the ſingular connection obſerved between mines of ſalt or ſalt ſprings and mountains of gypſum *.

[To be continued.]

IV. *Account of a large Tree in India.* By Colonel Ironside †.

By the ſide of the Ganges, about three miles above the fortreſs of Allahabad, near the ſmall pagoda of a goſſeir *(ſakir)*, I ſaw, on the 21ſt of November 1777, four trees called *kulberich*; the trunk of one of which appeared of ſo uncommon a ſize, that I ſent for a ſtring to meaſure its dimenſions, and found the circumference of it to be thirty feet ten inches. Its height is that of a pretty large beech, the rind or bark even, annulated and pulpy; and all the limbs ſmooth and very large, but rather ſcant of foliage; thoſe very ſmall branches which bore leaves being in cluſters, ſo that the tree, at ſome diſtance, ſeemed not unlike a ſtem of the thick ſpecies of *coralline*. The leaves are the ſize of oak leaves, but not ſinuated, and of a light though not bright green; the fruit is of the ſame colour, in ſhape almoſt conical like a pine, nine inches long, eleven inches and a half round the moſt ſwelling part, and with a ſoft velvet rind. Not being in bloſſom at that ſeaſon, I had no opportunity to obſerve the flower. The fakir told me that there were only thoſe four within 700 miles of the place; the ſeeds of them, which are ſhaped like a kidney bean, and as large as a *caravanſa*, having been ſent for by one of the

* And particularly of gypſum coloured by a red argil. To examine alſo why aſphaltes is commonly found in the neighbourhood of ſalt-pits.

42. To obſerve the different efflorescence of the different ſalts formed on the rocks and the ſurface of the earth, in order to determine their nature.

43. To note alſo the nature, the abundance, and what may be diſcovered in regard to the origin of mineral waters: to determine the temperature of them. C.

† From the *Oriental Collections*, Vol. I.

emperors, and ſown there. The groves and faſhion of the ground, as well as the fruit-trees, and a large ſtone wall about them, indicate the place to have been once a garden, and it is called to this time *Bejum-ke Baug*, or the *Queen's Garden*.

On my arrival at Patna, on the 2d of January 1778, I luckily met with a gentleman named Kerr, celebrated for his ſkill in botanical reſearches, who told me that the above-mentioned tree was of the ſpecies claſſed in the Linnæan ſyſtem under the name of *Adanſonia*, a deſcription of which is to be found in the ſixth edition of his *Genera Plantarum*, printed at Stockholm 1764, p. 352.

V. *Account of a Banian Tree in the Province of Bahar. By Colonel* IRONSIDE *.

NEAR *Manjee*, a ſmall town at the confluence of the *Devah* (or *Gogra*) and the *Ganges*, about twenty miles weſt of the city of Patna, there is a remarkably large tree, called a *bur* or *banian tree*, which has the quality of extending its branches, in a horizontal direction, to a conſiderable diſtance from its ſtem; and of then dropping leafleſs fibres, or ſcions, to the ground, which there catch hold of the earth, take root, embody, grow thick, and ſerve either to ſupport the protracted branches, or, by a farther vegetation, to compoſe a ſecond trunk. From theſe branches other arms again ſpring out, fall down, enter the ground, grow up again, and conſtitute a third ſtem, and ſo on. From the oppoſite pretty high bank of the Ganges, and at the diſtance of near eight miles, we perceived this tree of a pyramidical ſhape, with an eaſy ſpreading ſlope from its ſummit to the extremity of its lower branches, and miſtook it at firſt for a ſmall hill: we had no quadrant to meaſure its height; but the middle or principal ſtem is conſiderably higher, I think, than the higheſt elm, or other tree, I ever ſaw in England. The fol-

* From the *Oriental Collections*, Vol. I.

lowing

lowing compriſe ſome other of its dimenſions, which were taken with a cord of a given length:—

	Yards.	Feet.
Diameter of the branches from north to ſouth	121, or	363
Diameter of ditto from eaſt to weſt -	125, or	375
Circumference of the ſhadow of the extreme branches, taken at the meridian -	372, or	1116
Circumference of the ſeveral bodies or ſtems, taken by carrying the cord round the outermoſt trunks - - -	307, or	921

The ſeveral trunks may amount to fifty or ſixty.

N. B. The dropping fibres ſhoot down from the knots or joints of the boughs.

This tree, as well as the *peepel*, and many other large trees in India, is a creeper. It is often ſeen to ſpring round other trees, particularly round every ſpecies of the palm. The date, or palmyra, growing through the centre of a banian tree, looks extremely grand; and yet none of the European landſcape painters, who have delineated views of this country, have introduced this characteriſtic object into their pieces. I have frequently obſerved it alſo ſhooting from old walls, and running along them. In the inſide of a large brick-wall it lined the whole circumference of the internal ſpace of it, and thus actually became a tree turned inſide out.

Under the tree ſat a *fakir*, or devotee. He had been there twenty-five years; but he did not continue under the tree throughout the year, his vow obliging him to lie, during the four coldeſt months, up to his neck in the Ganges; and to ſit, during the four hotteſt months, cloſe to a large fire.

VI. *On the different Kinds of Cadmia, and particularly thoſe of Zinc and Cobalt.* *By* I. I. BINDHEIM *of Moſcow.*

[Concluded from Page 255.]

Of COBALT.

IT is ſcarcely a century and a half ſince people knew how to make uſe of cobalt ore. Brand, counſellor of the mines in Sweden, firſt proved that cobalt was a ſemi-metal, and that it poſſeſſed peculiar properties different from thoſe of other metals. He defended his opinion againſt various objections that were made to it; but it is ſtill believed by ſome, that it is a mixture of copper, iron, and arſenic: and this ſeems the more probable, as a fixed blue colour, fit for being employed in the arts and manufactures, is prepared with advantage at Vienna from iron and arſenic. This, however, does not place the circumſtance beyond all doubt, for it ſtill remains to be examined whether the arſenic and iron employed for that purpoſe be free from cobalt; and, until that be aſcertained, the fact muſt be involved in uncertainty; for both, or at leaſt one of them, may be mixed with cobalt.

Lehmann was of opinion, that the colouring matter of cobalt conſiſted of a fine alcaline earth combined with ſome particles of copper and iron; and he made experiments on this ſubject, by which he obtained blue glaſs. But from the deſcription he gives of his experiments it does not appear ſufficiently proved that ingredients free from cobalt were uſed for the mixture.

The reaſon why ſome may have been inclined not to aſcribe the principle which colours ſmalt to a metallic ſubſtance may have been, that they employed for their experiments a cobalt ore free from arſenic, and did not apply a ſufficiently ſtrong heat, without which the regulus of cobalt is difficult to be fuſed, and not ſo eaſily ſeparated: the principle which gives the blue colour to glaſs is, however, to be aſcribed

aſcribed certainly to the metal of cobalt, as has been placed beyond all doubt, and clearly proved by the experiments of M. Meyer, to be found in Sellers' Collections.

Some, on the other hand, have endeavoured to baniſh cobalt from the number of metals; but no one will certainly any longer doubt of its being a peculiar metal, ſince it is well eſtabliſhed, that ſimple ſubſtances are properly conſidered to be ſpecifically different when they exhibit various properties which other bodies do not poſſeſs, and that every ſubſtance is conſidered as ſimple when it cannot be ſeparated into different principles, and be again formed from them. Now this is confirmed in regard to cobalt; and it is found that it not only poſſeſſes properties different from thoſe of all other metals, but is itſelf a metal of a totally peculiar kind. Even though there be an analogy between iron, nickel, arſenic, and cobalt; and though, according to the ſuppoſed hypotheſis, the regulus of cobalt is only a variety of iron, and that it is difficult, if not impoſſible, to ſeparate it from cobalt; yet the latter ſtill remains a metal of a peculiar kind.

The firſt and principal reſearches for diſcovering cobalt mines were made in the Saxon mountains, and theſe procured to that country an opportunity of carrying on a conſiderable trade with this production. Good cobalt ore, fit for colouring, is found at preſent, though not in ſuch abundance, in Heſſe, Wurtemberg, the Harz, Bohemia, Pruſſia, Sileſia, and Sweden.

As far as I know, pure native cobalt has never yet been found; what is commonly pretended to be ſuch, is mineraliſed by arſenic. It is found in an oxygenated ſtate, and always combined with iron, and alſo mineraliſed with carbonic acid; in vitrious cobalt ore, by the ſulphuric and the arſenical acids; and to this belongs the ſo called flowers of cobalt, found in tender reddiſh cryſtals: it is alſo found mineraliſed by arſenic, with a little iron, in dull grey cobalt ore; by ſulphur and arſenic, with iron, in white arſenical

cobalt

cobalt ore; and by a little ſulphur, with abundance of iron without any arſenic, in ſulphurated cobalt ore.

When ſuch ore is treated in the fire, the arſenic evaporates, and the metallic and earthy particles remain behind, which, in order to be prepared for commerce, muſt be mixed with pounded quartz or ſand, afterwards moiſtened, and then packed up in caſks under the name of *ſaflor* or *zaffera*. If very fuſible glaſs be melted with a little cobalt ore, and if the maſs be finely pulveriſed, it produces ſmalt, which, by waſhing, may be fitted for an article of commerce of different qualities and ſorted. This ſmalt, however, contains in general an impure regulus of cobalt, which often conſiſts of a mixture of cobalt, iron, arſenic, and nickel, and is called *cobalt ſpeiſe*. If you wiſh to obtain a pure regulus of cobalt, you muſt chooſe for that purpoſe a cobalt ore as free as poſſible from foreign metallic ſubſtances. You muſt then roaſt it carefully according to the proportions of ſulphur and arſenic which you find in it, and reduce it by adding carbonaceous matter to take up the oxygen, and a good alcaline flux at a ſtrong fuſing heat. If the cobalt ore employed contains biſmuth, and is free from nickel, the regulus of biſmuth will be found at the bottom of the reduced cobalt in a ſeparated ſtate. This regulus is not pure, and ſufficiently free from iron; but it may be brought to purity, though with trouble and a conſiderable loſs of the regulus of cobalt. To effect this, it muſt be calcined with borax, on a teſt, in the ſame manner as copper, until it is no longer attracted by the magnet. Some, however, are of opinion, that iron is not the only metal attracted by the loadſtone, and that it exerciſes an attractive power over the fineſt blue colouring regulus of cobalt: but there are well-grounded objections againſt this idea, for that effect takes place only when the latter is not ſufficiently freed from iron; and according to the experiments of Bergmann, a compoſition of one part of iron and three parts of cobalt is attracted by the magnet; but if the proportion

proportion of the iron be conſiderably leſs, that effect is not produced.

The ſpecific gravity of a regulus of cobalt, purified as much as poſſible by the above method, is 7·700*; its colour is a pale greyiſh blue, but it becomes ſomewhat darker when expoſed to the atmoſphere: it is finely granulated on the fracture, and requires a ſtrong degree of heat to be fuſed, eſpecially when no arſenic is preſent; and therefore it happens that it is ſo difficult to extract the regulus by fuſion from cobalt ore which contains no arſenic. It is not, however, volatile, like the greater part of the ſemi-metals; and does not inflame and evaporate, but when calcined becomes a blackiſh oxyde.

When cobalt is pure, it diſſolves in acids with a red colour; when it does not diſſolve, it is a ſign that it is prevented by ſome foreign mixture: if the ſolution be green, it commonly implies the preſence of nickel.

With the vitriolic acid cobalt affords browniſh red cryſtals; the nitrous acid diſſolves it alſo of a red colour: by the muriatic acid regulus of cobalt is diſſolved with difficulty, but its calx eaſily diſſolves. This ſolution is red when cold, but when expoſed to a heat of 80 degrees becomes green; it ſhoots into red cryſtals inclining to blue: if theſe cryſtals are diſſolved in water, and a little of the muriatic acid be added, it produces that kind of ſympathetic ink which becomes green when heated, and inviſible when cold. The acetous acid diſſolves the calx of cobalt alſo of a red colour. If ſuch ſolutions are precipitated by volatile lixivious ſalts (ammonia), and the quantity neceſſary for ſaturation be added, it is re-diſſolved of a dark red colour.

In the wet way the oxalic acid, and in the dry way iron, have the greateſt affinity with cobalt. It combines with all metals except ſilver, lead, and biſmuth. Regulus of cobalt unites only weakly with ſulphur, but is fully diſſolved by ſulphat of pot-aſh.

* Bergmann Sciagr., but in his Diſſertation on Nickel he makes it 8·12.

VII. *Singular Cure of a young Woman, effected by expelling from the Stomach, &c. the Larvæ of certain Insects. By* M. Odhelius *.

THE account of this singular case was transmitted to M. Odhelius, together with some of the larvæ, by M. Flank, surgeon of Carlstadt, who, during the course of forty years practice, never saw any of the like kind discharged from the human body. The patient, who was seventeen years of age, and who for three years had been quite regular, became indisposed in the year 1786, and complained of a violent pain and griping in her stomach, with a head-ache and confusion in the morning, a burning in the throat, and great lassitude. These symptoms were lessened after repeated eructation; but the disorder still increased. Mineral water with jalep powder was prescribed, and the larvæ began gradually to be discharged; but as the patient did not find much relief, and as she nauseated jalep powder, aloe pills, with jalep resin, and mercurius dulcis, were administered in its stead, and about a quart of mineral water each time; by which means these troublesome guests were gradually so completely expelled, that the patient, in the course of a few weeks, was perfectly cured. The larvæ were transmitted to the Cabinet of Curiosities belonging to the Academy of Sciences. Professor Wilke found, on examining them, that they were of the species described by Reaumur under the name of *Vers a queue de rat*†, and which belong to a kind of two-winged fly, called the Pendulous Fly, *Musca pendula* L.; because the larvæ are suspended, as it were, by a long thread, which is their organ of respiration. These larvæ, which the Professor examined, were of a yellowish-brown colour, from four to six lines in length, with a tail of about the same extent; a cylindric body, from half a line to a line in thickness, cut

* From *New Transactions of the Academy of Sciences at Stockholm*, Vol. X.

† Memoires pour l'Hist. des Insectes, T. IV. Mem. 11. p. 443.

across

acroſs ſomewhat obliquely before, and conical towards the tail. As the patient, before ſhe fell ill, had uſed a great deal of milk and cheeſe, M. Wilke was of opinion, that ſome of the eggs of theſe flies had been conveyed into her ſtomach in the rind of the cheeſe.

VIII. *On the Signs exhibited by Animals which indicate Changes of the Weather, with Remarks on other Prognoſtications.* *By* M. Toaldo *.

THE fluids and ſolids of organiſed beings, and their animal machines, are conſtructed in ſuch a manner that a certain degree of motion puts them in a good ſtate, while an augmentation or diminution of it deranges and deſtroys that ſtate. The fluids, which by their nature are eaſily moved, as well as the fibres, which are highly ſuſceptible of irritation, are readily affected by changes of the ſurrounding atmoſphere, and ſuffer from their impreſſions, whether the air varies in its weight or qualities, or is changed in regard to its elaſticity. We find, among thoſe who are ſound and in perfect health, vivacity, good ſpirits, and great agility, when the air is pure and elaſtic; on the other hand, when the air becomes light and damp, and is deprived of its elaſticity, it throws the body into a ſtate of languor and debility. Valetudinarians, whoſe conſtitutions are delicate, or who are advanced in life, are much ſooner ſenſible of the impreſſions occaſioned by changes of the weather than thoſe who are ſtrong and robuſt. In general the ſenſes of men, who in their way of life deviate from the ſimplicity of nature, are coarſe, dull, and void of energy. Thoſe alſo who are diſtracted by a thouſand other objects, ſcarcely feel the impreſſions of the air; and if they ſpeak of them to fill up a vacuum in their miſerable and frivolous converſation, they do it without thinking of their cauſes or effects, and without

* From his *Meteorological Eſſays*.

ever

ever paying attention to them. But animals which retain their natural inſtinct, which have their organs better conſtituted and their ſenſes in a more perfect ſtate, and which beſides are not changed by vicious and depraved habits, perceive ſooner, and are more ſuſceptible of the impreſſions produced in them by variations of the atmoſphere, and ſooner exhibit ſigns of them.

Until the new diſcovery of animal electricity little attention was paid to theſe ſigns, which were conſequently aſcribed to a certain natural preſcience. But as the electric matter iſſuing from the earth diffuſes itſelf through the atmoſphere, it muſt penetrate and agitate the frail machines in queſtion; and as it carries with it vapours and exhalations of various kinds, theſe muſt produce, on machines ſo delicate, different ſenſations, which make them move in a different manner; and, according as the received impreſſion is agreeable or troubleſome, they exhibit ſigns of joy or ſadneſs; ſend forth cries, or are ſilent; move, or remain at reſt; as is obſerved in all kinds of animals, without excepting man, when the weather is about to change.

In the laſt place, internal and animal electricity, which in all probability is the agent of life and the grand ſource of organic motion, muſt be as much ſubject to modifications as the external electricity, from which it acquires new force and activity by the vapours and humidity of the atmoſphere, which abſorbing the electric matter in abundance, or ſerving it as a conductor, draws it off from the animal machine. Hence ariſes that languor and debility which are experienced during wet weather and when the ſouth winds prevail; and for the ſame reaſon the moiſture which has penetrated the organs, at leaſt thoſe that are weak or have ſuffered any hurt or injury, or been expoſed to ſome new agitation, produces uneaſineſs and occaſions pain. It is difficult to explain clearly and with preciſion how all this takes place; that is, how the electricity is excited, and by what mechaniſm exhalations and vapours affect animals, and pro-

duce

duce changes in their bodies, ſince we are not acquainted with the curious organiſation of the moſt delicate parts of theſe machines; but we can obſerve and perceive the progreſs and general conſequences of theſe phenomena, as well as of thoſe by which they are produced. The following are the common and familiar ſigns exhibited by animals, which indicate changes of the weather, and which are not taken ſo much from the agricultural poet, who firſt collected them, as from common obſervation:

1. When the bats remain longer than uſual abroad from their holes, fly about in greater numbers and to a greater diſtance than common, it announces that the following day will be warm and ſerene; but if they enter the houſes, and ſend forth loud and repeated cries, it indicates bad weather.

2. If the owl is heard to ſcream during bad weather, it announces that it will become fine.

3. The croaking of crows in the morning indicates fine weather.

4. When the raven croaks three or four times, extending his wings and ſhaking the leaves, it is a ſign of ſerene weather.

5. It is an indication of rain and ſtormy weather when ducks and geeſe fly backwards and forwards; when they plunge frequently into the water, or begin to ſend forth cries and to fly about.

6. If the bees do not remove to a great diſtance from their hives, it announces rain; if they return to their hives before the uſual time, it may be concluded that it will ſoon fall.

7. If pigeons return ſlowly to the pigeon-houſe, it indicates that the ſucceeding days will be rainy.

8. It is a ſign of rain or wind when the ſparrows chirp a great deal, and make a noiſe to each other to aſſemble.

9. When fowls and chickens roll in the ſand more than uſual, it announces rain: the caſe is the ſame when the cocks crow in the evening, or at uncommon hours.

10. Peacocks, which cry during the night, have a preſenſation of rain.

11. It is believed to be a ſign of bad weather when the ſwallows fly in ſuch a manner as to bruſh the ſurface of the water, and to touch it frequently with their wings and breaſt.

12. The weather is about to become cloudy, and to change for the worſe, when the flies ſting, and become more troubleſome than uſual.

13. When the gnats collect themſelves before the ſetting of the ſun, and form a ſort of vortex in the ſhape of a column, it announces fine weather.

14. When ſea-fowl and other aquatic birds retire to the ſea-ſhore or marſhes, it indicates a change of weather and a ſudden ſtorm.

15. If the cranes fly exceedingly high, in ſilence, and ranged in order, it is a ſign of approaching fine weather; but if they fly in diſorder, or immediately return with cries, it announces wind.

16. When the dolphins ſport and make frequent leaps, the ſea being tranquil and calm, it denotes that the wind will blow from that quarter from which they proceed.

17. If the frogs croak more than uſual; if the toads iſſue from their holes in the evening in great numbers; if the earth-worms come forth from the earth, and ſcorpions appear on the walls; if the ants remove their eggs from their ſmall hills; if the moles throw up the earth more than uſual; if the aſſes frequently ſhake and agitate their ears; if the hogs ſhake and ſpoil the ſtalks of corn; if the bats ſend forth cries, and fly into the houſes; if the dogs roll on the ground, and ſcratch up the earth with their fore-feet; if the cows look towards the heavens, and turn up their noſtrils as if catching ſome ſmell; if the oxen lick their fore-feet, and if oxen and dogs lie on their right ſide; all theſe are ſigns which announce rain.

18. The caſe is the ſame when animals crowd together.

19. When

19. When goats and ſheep are more obſtinate and more deſirous to crop their paſtures, and ſeem to quit them with reluctance; and when the birds return ſlowly to their neſts, rain may ſoon be expected.

Other Signs which announce Changes of the Weather.

1. If the flame of a lamp crackles or flares, it indicates rainy weather.

2. The caſe is the ſame when the ſoot detaches itſelf from the chimney and falls down.

3. It is a ſign of rain, alſo, when the ſoot collected around pots or kettles takes fire in the form of ſmall points like grains of millet; becauſe this phenomenon denotes that the air is cold and moiſt.

4. If the coals ſeem hotter than uſual, or if the flame is more agitated, though the weather be calm at the time, it indicates wind.

5. When the flame burns ſteady, and proceeds ſtraight upwards, it is a ſign of fine weather.

6. If the ſound of bells is heard at a great diſtance, it is a ſign of wind, or of a change of weather.

7. The hollow ſound of foreſts; the murmuring noiſe of the waves of the ſea; their foaming, and green and black colour, announce a ſtorm.

8. Good or bad ſmells, ſeeming as if it were condenſed, are a ſign of a change of weather; either becauſe exhalations ariſe and are diſperſed in more abundance, which is a ſign of an increaſe of electricity; or becauſe the air does not diſpell or raiſe theſe exhalations, which indicates that the conſtitution of the atmoſphere is motionleſs, light, and void of elaſticity.

9. When the ſpiders webs and the leaves of the trees are agitated without any ſenſible wind, it is a ſign of wind, and perhaps of rain; becauſe it denotes that ſtrong and penetrating exhalations ariſe from the earth.

10. Theſe ſigns are leſs equivocal when the dry leaves and chaff are agitated in a vortex, and raiſed into the air.

11. A frequent change of wind, accompanied with an agitation of the clouds, denotes a ſudden ſtorm.

12. A want or too great a quantity of dew being a mark of a ſtrong evaporation, announces rain: the caſe is the ſame with thick, white hoar-froſt, which is only dew congealed.

13. If ſalt, marble, and glaſs become moiſt ſome days before rain; if articles of wood, doors, and cheſts of drawers ſwell; if the corns on the feet and the ſcars of old wounds become painful; all theſe ſigns indicate that aqueous vapours are exhaled from the earth, and are no doubt directed by the electric matter, which diffuſes itſelf then in greater abundance and penetrates every body. Hence it happens that ſtones become moiſt, that wood ſwells, and ſalt becomes deliqueſcent by the moiſture. When the ſtones after being moiſt become dry, it is a ſign of fine weather.

14. On the other hand, when the weather inclines to rain, the water is ſeen to diminiſh in vaſes and fountains, becauſe the humidity is then carried away by the evaporation of the electric matter.

15. It is certainly a ſurpriſing phenomenon to ſee the earth, after very long and very abundant rains, to be ſometimes almoſt dry, the roads quite free from dirt, and the hands to become arid and parched. This is a ſign that the rain has not altogether ceaſed, and denotes a continual efflux of electric matter, which being renewed carries with it, in the form of vapours, all the moiſture that falls on the earth.

16. There is ſometimes, however, a great deal of dirt even after a very moderate rain, which in that caſe is a ſign of fine weather, becauſe it indicates that evaporation has ceaſed. Dry ſtones and moiſt earth announce fine weather; dry earth and moiſt ſtones announce rain.

17. The winds which begin to blow in the day-time, are much ſtronger, and endure longer, than thoſe which begin to blow only in the night.

18. Weather, whether good or bad, which takes place in the

the night-time, is not, in general, of long duration; and, for the moſt part, wind is more uncommon in the night than in the day-time. Fine weather in the night, with ſcattered clouds, does not laſt.

19. A Venetian proverb ſays, that a ſudden ſtorm from the north does not laſt three days.

20. The hoar-froſt, which is firſt occaſioned by the eaſt wind, indicates that the cold will continue a long time, as was the caſe in 1770.

21. If it thunders in the month of December, moderate and fine weather may be expected.

22. If it thunders at intervals in the ſpring time, before the trees have acquired leaves, cold weather is ſtill to be expected.

23. If the wind does not change, the weather will remain the ſame.

Such almoſt are the ſigns of the variations of the atmoſphere; but I will not be anſwerable for the certainty of them all. Plutarch, in his Problems, where it is aſked why a horſe who has eſcaped from a wolf becomes fleeter, replies, that becauſe, by a ſingle action, but executed with great force and vigour, he has acquired a diſpoſition to running and a habit of ſpeed; or perhaps, becauſe he is naturally ſwift and agile: but he adds, perhaps neither of theſe is true. This obſervation, I am afraid, will apply to ſome of the vulgar prognoſtics of the preſent day. For example, we are told, that it is a ſign of fertility in any year when a fly is engendered in an acorn of that year; and that it is the ſign of a peſtilential year, if there iſſues from it a ſpider. Should the reaſon be aſked, it might be replied, that neither of theſe is true. I might venture to ſay as much of thoſe popular tales in regard to certain critical days of the month; yet we muſt ſtill have ſome reſpect for popular proverbs, which are often founded on obſervation and reaſon. Thus it is ſaid, that if it rains on the 3d of May, the day of the Holy Croſs; or on the 23d of April, St. George's day; or the

15th of June, St. Vitus's day, &c.; in the firſt caſe the nuts will be ſpoiled; in the ſecond, the figs; and in the third, the grapes. All this may be true to a certain degree, that is to ſay, when it rains for a certain number of days about theſe periods; becauſe, if rain falls at the time when fruit-trees are in bloſſom, it carries off the fecundating farina, and by theſe means renders them barren.

In regard to the general qualities of the ſeaſons, and their influence, attention may be paid to the following ſigns:— If the earth and air abound with inſects, worms, frogs, locuſts, &c.; if the walnut-tree has more leaves than fruit; if there are large quantities of beans, fruit, and fiſh; if the ſpring and ſummer are too damp; if hoar-froſt, fogs, and dew come on at times when they are not generally ſeen, the year will be barren: the oppoſite ſigns announce fertility and abundance. Animals ſeem alſo to foreſee and prognoſticate fertility or barrenneſs: it is ſaid that when the birds flock together, quit the woods and iſlands, and retire to the fields, villages and towns, it is a ſign that the year will be barren.

A great quantity of ſnow in winter promiſes a fertile year, but abundant rains give reaſon to apprehend that it will be barren. A winter, during which a great deal of ſnow and rain falls, announces a very warm ſummer. It is generally believed that thunder and ſtorms in winter prognoſticate abundance, becauſe they fertiliſe the earth. When the ſpring is rainy, it produces an abundant crop of hay and of uſeleſs herbs, but at the ſame time a ſcarcity and dearth of grain. If it is warm, there will be plenty of fruit, but they will be almoſt all ſpoilt. If it is cold and dry, there will be few fruit or grapes, and ſilk-worms will not thrive. If it is only dry, there will be few fruit, but they will be good. In the laſt place, if it is cold, the fruit will be late in coming to maturity.

If the ſpring and ſummer are both damp, or even both dry, a ſcarcity and dearth of proviſions is to be apprehended.

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If the ſummer is dry, there will be little corn: diſeaſes will alſo prevail; but they will be more numerous if it is warm. If it is moderately cold, the corn will be late; but there will be a great deal of it; and the ſeaſon will occaſion few diſeaſes.

A fine autumn announces a winter during which winds will prevail: if it is damp and rainy, it ſpoils the grapes, injures the ſown fields, and threatens a ſcarcity. If it be too cold, or too warm, it produces many maladies. A long ſeverity of the ſeaſons, either by winds, drought, dampneſs, heat or cold, becomes exceedingly deſtructive to plants and animals. In general, there is a compenſation for rain or drought between one ſeaſon and another. A damp ſpring or ſummer is commonly followed by a fine autumn. If the winter is rainy, the ſpring will be dry; and if the former is dry, the latter will be damp. When the autumn is fine, the ſpring will be rainy. That this alternation is in general verified may be ſeen in a Journal carried on for forty years, and formerly edited by M. de Poleni.

IX. *On the Effects of Oil in Caſes of the Bite of Serpents; republiſhed from the Charleſtown (South-Carolina) City Gazette*.*

Meſſrs. FRENEAU and PAINE,

I READ with pleaſure, in your paper of the 21ſt of November, "ſome ſhort directions for the cure of the plague," compoſed from a ſmall pamphlet lately publiſhed by Count Berchtold at Vienna, by the uſe of *ſweet olive oil.*

To take off the ſharp edge of misfortune, or to meliorate the condition of man, is a godlike employment. Count Berchtold will be deſervedly claſſed by the philanthropiſt among the benefactors to mankind.

In great cities, particularly in London, a number of per-

* From the *American Medical Repoſitory.*

ſons procure their livelihood by catching vipers. They are employed by chemiſts, apothecaries, &c.

I remember, ſome years before leaving England, to have read, in the Philoſophical Tranſactions of the Royal Society in London, a curious circumſtance relative to one of theſe viper-catchers.

A member of the ſociety had received, caſually, information that a man engaged in this buſineſs was frequently bitten, and that he cured himſelf by *ſweet olive oil*. After conſiderable inquiry, the viper-catcher was found, and the queſtions aſked, whether he did cure himſelf by the oil? and whether he was willing to gratify a number of gentlemen of the fact? The man anſwered affirmatively to both queſtions. Accordingly, a moſt numerous meeting of the Royal Society was convened, compoſed of a conſiderable number of the nobility, &c. The viper-catcher attended, accompanied by his wife, with a large viper; and laying his arm naked to the ſhoulder, ſuffered the irritated reptile to ſtrike, which it did very forcibly. His wife permitted the poiſon to operate till her huſband's head, face, and tongue were greatly ſwelled, his arm and face alſo very black, and his ſenſes much affected, when he applied the oil, by pouring a ſmall quantity down his throat, and bathing the part bitten. The man gradually and ſoon recovered.

This circumſtance being ſtrongly impreſſed upon my mind, and knowing that the poiſon of an Engliſh viper is conſidered in that country the moſt ſubtile in nature, determined me to try its antidotal power in the bite of the rattleſnake, the firſt opportunity which ſhould offer, on my retirement from Charleſtown to the back country, now called Pendleton County. I was alſo particularly impelled to make the trial, from a conſideration of the newneſs and wildneſs of the country, and the number of my family, beſide which there were hardly a dozen more in the country. This was in the year 1786.

In about a month after my arrival, a perſon in full ſpeed

came to my camp, and moſt urgently begged to know if I could aſſiſt a man who had juſt been bitten by a very large rattle-ſnake. Although I lamented the misfortune, I rejoiced at the opportunity it offered to aſcertain fully the property of olive oil as an antidote to this deadly poiſon; accordingly I put a phial of oil in my pocket, and mounted the meſſenger's horſe.

When I arrived at the unfortunate man's cabin, he ſtruck me as the moſt frightful object I had ever beheld. His head and face were prodigiouſly ſwelled, the latter black; his tongue proportionably enlarged, and out of his mouth; his eyes as if ſhooting from their ſockets; his ſenſes gone, and every appearance of immediate ſuffocation. He had been ſtruck on the ſide of the foot, about the middle, in the hollow.

Immediately, but with great difficulty, I got down two table-ſpoons full of oil. Its effect was almoſt inſtantaneous, and aſtoniſhingly powerful in counteracting the poiſon, as appeared by the ſtrong though quick convulſions that followed. In about thirty minutes it operated ſtrongly, both emetically and cathartically; after which the ſwelling of the head, face, &c. gradually abated, and the tongue began to aſſume its place. In about two hours he was ſo far recovered as to be able to articulate, and from that time recovered faſt. The oil, inwardly taken, and applied to the foot and leg, both exceedingly ſwelled, did not exceed ſeven or eight ſpoons full.

The number of caſes, of a like nature, in the courſe of twelve years, has been conſiderable; in all which, olive oil has proved itſelf to be peculiarly adapted and fully adequate to the worſt of caſes, if timely applied. It is a remedy which every perſon may command (may have at hand when others cannot be procured), and ought not to be without; indeed, many cautious people here carry a ſmall phial of oil conſtantly about them. It has alſo been uſed with equal ſucceſs when horſes, cattle, and dogs have been bitten. Thus

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is the mind relieved from terror in thoſe whoſe occupation ſubjects them to the bite of the ſnakes, from a well-grounded confidence in the certain efficacy of the oil, and to which every one may have inſtant recurrence.

The caſe, I am informed, has occurred, where the oil ſucceeded when given to a woman bitten by a mad dog, under ſtrong ſymptoms of hydrophobia; but at preſent I am not ſufficiently in poſſeſſion of particulars to warrant its communication.

I can hardly excuſe myſelf of criminal neglect in having ſo long omitted to make thus public this ſovereign antidote to the worſt of animal poiſons. The knowledge of the efficacy of the olive oil is abundantly diffuſed in this county, and partially in ſome of the adjoining counties.

The inſertion of the foregoing particulars in your City and Carolina Gazettes, muſt make its invaluable properties generally known.

With great eſteem, I am, &c.

Pendleton County, July 4, 1798. J. MILLER.

X. *Thoughts on Deafneſs; with a new Mode of making Deaf People hear. Written* 15*th December* 1798, *by* D. WHYTE, M.D.

His Majeſty's Ship Atlas,
Torbay, 9*th Auguſt* 1799.

SIR,

HAVING ſeen in a late newſpaper an account, copied from your Magazine, of a new mode of conveying ſounds for the benefit of deaf perſons, propoſed by Profeſſor Blumenbach, I have extracted from my Medical Diary what I wrote ſome months ago on this ſubject.

As my ideas were formed without any knowledge of the German diſcovery, you will oblige me much by giving them a place in your very valuable Miſcellany.

I am, Sir, your humble ſervant,

The Editor of the Philoſophical Magazine. D. WHYTE.

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IT has been a general remark, that deaf people ſpeak in a very low tone of voice, while they themſelves conceive that they ſpeak very loud. It is ſuppoſed that the deaf perſon, not being ſo eaſily affected by ſound, anſwers in what he believes to be the proper and correſponding pitch.

I came down laſt night from London to Goſport in the ſtage-coach: one of the paſſengers, a woman, was extremely deaf. A few weeks before, I had travelled in a ſimilar vehicle with an unentertaining companion of the ſame kind. My attention has been thereby turned to the ſubject; and I am led to make the following remarks:—

For that deafneſs ariſing from impaired excitability of the organ of hearing, properly ſo called, I know of no remedy: I confine what I have to ſay to that ſpecies of it which is occaſioned by a diſeaſed ſtate of tympanum, or the external meatus.

In either of theſe laſt caſes ſounds communicated by the external ear appear to be of a lower pitch than in reality they are; while, if the Euſtachian tube continues permeable, thoſe communicated through the mouth appear higher and louder than uſual. Even where the ear and all its parts and paſſages are in health, ſounds communicated through the mouth are more perfect than thoſe which paſs through the external meatus. This, perhaps, is occaſioned partly by the concavity of the mouth, and partly by the ſolidity of the teeth. In perſons whoſe tympanum, or whoſe external meatus is diſeaſed, it is probable that the ear, from habit, becomes more ſenſible to the vibrations of ſound communicated through the Euſtachian tube, than, without ſuch a circumſtance, it otherwiſe would be.

Sound being more eaſily communicated through the medium of ſolid than of rare bodies, I apprehend that a long wire held in the mouth would be much more ſerviceable to ſuch a deaf perſon, than the largeſt trumpet applied to the external ear.

It poſſeſſes alſo the advantage of being extremely portable, and

and may at all times be uſed without inconvenience, and almoſt without being obſerved.

I ſhall certainly make trial of it in the firſt caſe that occurs.

XI. *On the Aſſaying of Ores by Fuſion. By Mr.* DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

MY Paper in the Number for July concluded with a table of the proportions requiſite to obtain, from all the various iron-ſtones, an accurate aſſay; the perfection of which is always indicated by the ſuperior tranſparency of the flux, and the ſuper-carbonation of the metallic button. By ſcrupulouſly following theſe and ſimilar proportions as the exigencies of the ore may point out, crude iron will always be obtained of the fineſt quality, carbonated beyond whatever is produced in the large way of manufacture, and its ſurface covered with a beautiful carburet of iron, either in ſmall ſhining ſpecula, or in the ſtate of a thin membrane. By a ſlight gradation of change in the proportions of the component parts of the flux, the metal of the ſame iron-ſtone may be made to paſs through all the inferior ſtates.

Since, then, all iron-ſtones in the aſſay-furnace may be made to give out their iron at pleaſure, of all the various qualities, it is ſurely erroneous to aſſert, that ſuch and ſuch iron-ſtones contain ſuch and ſuch qualities of iron; that this one affords metal of the fineſt quality, while that, on the contrary, yields iron fit only for forge-pigs or ballaſt; yet this is the univerſal language in the manufactory. In this, as in many inſtances, we accommodate the language to our ideas, rather than our ideas to truth. The ſuffrage of prevailing cuſtom has imperceptibly aſſociated with our ideas many abſurdities which we are afterwards aſhamed to acknowledge, and which darken the gleam of truth, or render

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it apparently ridiculous, merely becauſe it is at variance with our prejudices. Where ſcience guides not the manufacturer, or is ſcorned by him, his train of reaſoning, though far from being juſt, is ſhort; it is fitted to the narrow culture of his mind, and conſonant to a barbarous nomenclature of received uſage *.

In order to elucidate ſtill farther how much the quality of the iron is dependent upon the proportions of the mixtures, in combination with, or given to the ores, let a determinate quantity, ſay an ounce, of the oxyde of pure malleable iron be taken;—this we are phyſically certain contains no mixture except oxygen exiſting in quantity proportioned to the ſtage of oxydation, the quantity being aſcertained by its degree of obedience to the magnet; when the quantity of oxygen given

* I cannot reſiſt noticing one inſtance, prevalent at iron-works, of that blind reverence to the opinion of our predeceſſors, whoſe ſources of knowledge muſt neceſſarily have been few and contracted. When ſuper-carbonated crude iron is run from the furnace, it is frequently covered with a ſcurf, which when cold is found to be a coating of plumbago (carburet of iron) remarkably brilliant; ſometimes in ſmall ſpecks, and at other times in large flakes: this ſubſtance is univerſally denominated *ſulphur*, and, as the moſt expreſſive adjective for that quality, we ſay that the iron is *ſulphury*. There are not, perhaps, two ſubſtances ſo oppoſite in their degrees of inflammability, or ſo widely different in their properties, as ſulphur and plumbago; the exiſtence of the latter almoſt wholly ſuppoſes a total abſence of the former: yet, ſuch is the want of inveſtigation, or the ſlighteſt momentary reflection, that an indolent belief is paſſed as to the preſence of a ſubſtance diametrically oppoſite to that which is expreſſed. *Sulphur* has hitherto been the philoſopher's ſtone of the iron manufactory; to its preſence is attributed the production of bad iron—when the metal is in its moſt valuable ſtate, it is alſo *ſulphury*;—it prevents caſt iron from becoming malleable; and if *ſulphur* were altogether abſent, hard or white caſt iron could not be produced. If caſt iron is found coloured, it is by the *ſulphur*; is it cryſtalliſed and coloured, then it has ſulphur to exceſs; ſhould it have loſt its ſtrength, or have become looſe in the fracture by an exceſs of ſhrinkage in large caſtings, ſtill it is by the agency of ſulphur: in ſhort, in every proceſs in the manufacturing of iron, ſulphur explains the whole phenomena! it is execrated in one proceſs, and anxiouſly looked for in another.

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to it, by the decompoſition of water, exceeds 25 *per cent.* few traces of magnetic attraction are perceptible:—introduce this oxyde into a covered crucible, without any addition, and expoſe it to a violent degree of heat for 40 minutes, (longer in proportion to the quantity,) a button of highly oxygenated crude iron will be obtained: if the heat is continued longer than is neceſſary to effect this, a ſmall maſs of malleable iron will be found occupying the bottom of the crucible. The produce in either caſe will be ſhort of the real quantity of metal contained in the oxyde. When oxygenated crude iron is obtained, the ore from which it is produced, to uſe the common phraſeology, is ſaid to contain *bad iron.* That this has no relation to truth, will be ſeen by taking another portion of the ſame oxyde; let it be mixed either with chalk or lime, and a little bottle-glaſs, to conſtitute fuſibility, and expoſed to a ſimilar degree of heat with the former; the whole contents in iron will then be found revived, and occupying the bottom of the crucible in the ſtate of fine carbonated crude iron. Here then is a complete alteration in the quality of the metal, though obtained from the ſame ore; for we cannot conſider iron combined with oxygen, to which earthy baſes are given, in any other light than that of an ore. Again, let a portion of mixture, exactly ſimilar to the laſt, have added to it double or triple its weight of bottle glaſs, and ſubject the whole to an equal heat with the former experiments, nearly a complete revival of all the metal will be found to have taken place; its quality, however, will be highly oxygenated and brittle. Such experiments clearly demonſtrate, that the various qualities of crude iron are entirely owing to the mixtures in the ore, and their treatment; and that iron, conſidered as a ſimple metallic ſubſtance, is the ſame in point of quality in all ores.

If iron was originally formed in a metallic ſtate, its property of decompoſing water, whether caſually expoſed to a moiſt atmoſphere, or removed at various depths from the ſurface, furniſhes an hypotheſis as to the primitive principle

of iron ores; that part of the water—by far the greateſt—which remained undecompoſed, would ſerve as a medium, or vehicle of ſuſpenſion, and conveyance to the oxyde; this again, in its turn, would be depoſited either at the fountain-head, or at a greater or leſſer diſtance from it, according to the affinities exerted upon it by other ſubſtances with which it might come in contact. Correſponding with this ſuppoſition, we commonly find thoſe ores which are formed in vertical maſſes or knobs, approached by a great number of ſmall veins occupying the ſmalleſt fiſſure or crevice in the rock. Time, and the re-action of additional water and acids, would a ſecond time carry off a portion of the ore in chemical union; this, by the exertion of new affinities, would become precipitated, and mixed with the ſuſpended earths, to form regular ſtrata of iron-ſtone. To ſuch a primary and ſecondary agency of formation may be attributed the general ſuperior richneſs of ores found in irregular vertical maſſes, to that of iron-ſtones. The ſame cauſe will alſo explain why more determinate qualities of iron are obtained from primitive ores, than from thoſe of a ſecondary formation. In the former, the mixtures are commonly fewer, and the quality of the malleable iron more decided; in the latter, the quality of the metal is leſs certain, and more various, from the mixtures being more numerous. Hence we may alſo trace the reaſon of the ſuperior qualities and marks poſſeſſed by ſome of the foreign fabrics over each other, where the ſame fuel has been uſed, and the ſame courſe of manufacture followed.

Having ſo far conſidered crude iron, in regard to its fuſibility, and the facility with which it becomes changed into various degrees of carbonation or oxygenation, conſtituting a variety of qualities moſt pointedly diſtinguiſhed in commerce, and in which the metallurgiſt diſcovers widely different properties and characteriſtic forms; I ſhall next proceed to mention in what manner ſtrength may be given to any quality of crude iron which may probably be obtained

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by the fuſion of an ore, and from what ſource this property is derived.

Upon a former occaſion I have mentioned that iron, obtained from argillaceous ores, poſſeſſed a degree of ſtrength beyond that obtained from the other genera. This truth daily preſents itſelf to our obſervation in the large ſcale of manufacture; and however erroneous the reaſoning of the manufacturer as to the cauſe, yet ſo evident are the conſequences produced, that we muſt immediately attribute them to ſome ſource beyond the caſualties of operation in the ſmelting furnace. In the explanation of this fact, as on the degrees of oxygenation and carbonation in general, the manufacturer has recourſe to the exiſtent nature of the iron in the ore, and denominates the metal contained in ſuch and ſuch an ore to be "ſtrong, coarſe, ill-melting iron;" or "weak, tender iron, poſſeſſing no body." That iron-ſtones and ores yield, in the operation of ſmelting, different qualities of crude iron, as to ſtrength, is an undeniable fact; and that the ſame variety attaches to iron when converted to malleability is a truth daily evinced in our forges: yet theſe facts by no means entitle us to conclude, without farther inveſtigation, that theſe varieties of ſtrength are the hereditary property of the priſtine formation of the metal. This inference accords with a haſty view of the matter, and a bare comprehenſion of effects, without tracing to its ſource the modifying principle of the whole. The theory which I have adopted, and which in every ſtep I have found ſupported by numerous experiments, upon different ſcales, and by a long courſe of practical obſervation, explains to me, with much more eaſe and harmony, the whole phenomena of quality in ores and iron-ſtones.

To illuſtrate that part of my theory relative to ſtrength, let the preceding experiment, wherein carbonated crude iron was produced from the oxyde of pure iron, be repeated with the addition of a little pure clay. If the clay added be half the weight of the lime alſo uſed, the iron will be found, when

when ſubjected to the gauge, much ſuperior in ſtrength; and if the experiment be accurately performed, the metal will be but a little reduced in point of carbonation. The following proportions will give accuracy to the reſult:—Oxyde of iron, 4 parts—Lime, 2—Clay, 1—Glaſs, 3 = 10 parts. By mixing clay with the flux in all experiments, the ſtrength of the crude iron is improved. This point may be urged ſo far as to form, by an extra-addition of clay, a flux of difficult fuſion; in which the iron becomes ſuſpended in globules, which are partially malleabiliſed apart from each other. Crude iron, obtained with a ſuperior mixture of clay, in all its ſtages of quality, poſſeſſes a greater degree of ſtrength than iron from calcareous iron-ſtones. Iron from argillaceous iron-ſtone is reckoned ſtrongeſt when carbo-oxygenated; that extracted from calcareous iron-ſtone is reckoned to poſſeſs moſt ſtrength when oxygenated, mottled. I would far exceed the limits of the preſent communication, were I to enter fully into this curious ſubject, and particulariſe the different reſults obtained by the fuſion of ores with different earths in various proportions: all my experiments have fully proved to me, that originally the quality of the iron, ſimply conſidered, was the ſame; that, as it underwent change by decompoſition and new combination, it became united to foreign ſubſtances, poſſeſſing widely different properties; and which mixture, by a general fuſion, imparts to the metal various properties, ſeldom homogeneous, but frequently otherwiſe: in ſhort, that the numberleſs mixtures with which it is combined are not neutral in fuſion, but convey an alteration to the quality of the reduced iron. I hope to reſume this ſubject when my experiments will be more extended by the examination of a vaſt variety of iron-ſtones, and ſhall then point out the conſequent effects of their application to the manufacture of caſt and malleable iron.

The aſſaying of primary ores comes next under conſideration. Theſe, I have already ſaid, poſſeſs a much greater diverſity of external character, as well as internal variety, than

thoſe of iron-ſtone. When aſſayed with a vitreous flux, either of ſalts, alkalies, or ſilex, the reſults are rendered very uncertain and erroneous: when pot-aſh, tartar, &c. are uſed, the crucible is often deſtroyed, and the compound entirely loſt: when bottle glaſs and a mixture of theſe are uſed, the ſcoria formed is ſo very black and ponderous as to give the moſt preſumable indication of the ſecretion of metallic oxyde: this is afterwards verified by fuſing the maſs with a mixture of dried chalk and charcoal, a globule of metal will be obtained, which evinces the richneſs of the ſcoria; this, having loſt its colouring principle (the metal), becomes clear and tranſparent. The reſults from theſe ores by fuſion afford various products, and lead to different concluſions: I ſhall mention ſeveral of them.

The Cumberland iron ore, when introduced into a crucible without any additional mixture, fuſes eaſily, and forms an opaque ſcoria, internally of a black colour, but towards the ſurface covered with fine ſhades of brown: this ariſes from a partial oxygenation of the ſemi-revived metal while cooling, and is often injured by a freſh combination of oxygen. If the crucible remains found, and the melted maſs is kept in a ſtate of extreme diviſion for an hour, a conſiderable quantity of metal will be found precipitated, but ſo highly oxygenated as to ſhiver to pieces if expoſed to air before it is entirely cooled. If, when the crucible is taken from the furnace, it be ſlightly inclined to one ſide, and the vitrified fluid entirely removed from the ſurface of the metal, a violent deflagration will immediately enſue, the ejected globules will be thrown three feet upwards from the mouth of the crucible: if the quantity of metal does not exceed 500 grains, it will totally diſappear, except a rough dark-blue oxyde in the bottom of the crucible, not above 1-4th of the original weight. The metal thus oxydated will be found in ſmall ſpherules of a blackiſh colour, and ſpongy around the ſpot occupied by the crucible.

This curious appearance is in fact a combuſtion of iron by

by oxygen gas, furniſhed by the decompoſition of atmoſpheric air: it is an operation which the accurate obſerver may daily ſee manifeſted in almoſt every department of the foundery and forge. By a juſt comprehenſion of it, and a proper appreciation of its effects, we have a key for the elucidation of the ſource and action of many facts long wrapped in myſtery, or which have been explained upon principles deſtitute of ſtability, and unallied to the fundamental operations of truth.

In place of withdrawing the crucible immediately upon the ſeparation of the crude iron, were it to remain for an hour longer under an inferior degree of heat, ſo as to conſolidate the metal without again fuſing it, then the whole maſs would be found malleable; the ſcoria light and porous. In one of my experiments upon the hæmatites variety, I obtained from 1 lb. averdupoiſe, or 7000 Troy grains, an ingot of fine malleable iron weighing 4486 grains; a produce equal to 64 *per cent.* *

An oxygenating flux was however uſed, and nearly the whole contents in iron previouſly revived. In experiments without the addition of a flux, the tranſmutation from caſt to malleable iron is ſhortened, but the produce is not more than 5-8ths of the intrinſic contents of the ore. Even this proceſs may be conſiderably ſhortened by removing the covering of vitrified earths floating upon the ſurface of the metal: thus the ſmall portion of the carbonaceous principle conſtituting fuſibility is almoſt inſtantly carried off by the combination of oxygen; the metal loſes its fluidity, becomes thick and clotted, and more ſpeedily paſſes into the malle-

* This might be adduced as a proof that crude iron contains more parts congenial to malleability than is generally admitted, or than is manifeſted in the operation of converting it into malleable iron at the forge: the loſs there has already been mentioned to amount to from 30 to 50 *per cent.* of real metal; in this aſſay, however, the produce in malleable iron was only 4,5 leſs than when accurately aſſayed, and rich carbonated crude iron was obtained; in which, too, the carbon conſtituted a part of the weight.

able ſtate. In this proceſs the quantity of malleable iron obtained is ſtill leſs than in the two former: the ſurface of the metal being expoſed by the removal of the ſcoria, oxydation takes immediate effect; and whilſt malleability is pervading the under ſurface of the metallic button, the upper one becomes reduced to a blackiſh blue oxyde. In this operation a ſtriking proof is afforded of the great affinity which oxygen has, in high temperatures, to caloric. Were the ſurface of ſuch highly oxygenated crude iron expoſed, while fluid, to atmoſpheric air, at an ordinary medium, for 1-6th of the time, its whole metallic properties would be completely deſtroyed: in the preſent inſtance nearly one-half of the metal is preſerved, although its ſurface is expoſed to the action of a violent current of gas, ignited to the higheſt pitch of whiteneſs *. In the proper aſſay of this ore I have found all the varieties

* I have frequently obſerved, in experiments with pretty deep crucibles, where the moſt violent heats were excited, and where the fluid metal had aſſumed a whitiſh-blue colour ſomewhat inclining to azure, that the quantity of oxyde formed was imperceptible, and never viſible while the heat was continued of equal intenſity; when this agent became leſs urgent, the ſurface of the metal became oxydated as uſual. When a regulus of crude iron thus expoſed was wiſhed to be obtained free from oxydation, a little dry charcoal was introduced into the crucible ſo as to cover the regulus; this prevented the action of the air from taking effect while cooling, and preſerved the button ſmooth. During ſuch expoſures, when no oxyde was produced, I have noted a loſs of metallic parts equal to 5.7, or 10 *per cent.* when the ſpace of time did not exceed one hour. Among ſeveral conjectures reſpecting the cauſe of this deficiency in weight, and real abſtraction of metal, the two following have with me moſt weight. 1ſt, Either the metal deflagrates in ſmall particles, which are thrown out of the crucible in ſparkles, made inviſible by the tranſcendent brightneſs of the ſurrounding heat: Or, 2d, that in conſequence of the fluid metal being expoſed to ſuch a great degree of heat, in contact with oxygenous gas, part of it becomes acidified, and forms the ferric acid. The truth of this laſt ſuppoſition will not eaſily be aſcertained, ſince it will be difficult to conſtruct an apparatus capable of receiving or containing it, ſhould it prove to be an elaſtic fluid: it is, however, conſonant to the doctrines of the new theory, and the poſſibility of the exiſtence of the ferric acid is by no means excluded. The diſſipation of carbon

varieties ſuſceptible of various degrees of carbonation: for the moſt part I have uſed chalk and charcoal for the reduction of the ore into carbonated crude iron. In the hæmatites variety, for 1 lb. averdupoiſe I have commonly added 6 oz. dried chalk and 3-4ths oz. of charcoal; and for the ſplinty blue ore alſo a ſimilar mixture. From both of theſe I have obtained the richeſt ſort of crude iron. In the manufactory theſe varieties are always reckoned to produce the hardeſt and moſt infuſible qualities of crude iron: when the

carbon or oxygen will not nearly explain this phenomenon, as they exiſt in much leſs proportion; and while the iron remains in a crude ſtate, the latter accumulates in proportion as the former becomes expelled. Beſides, a greater product in malleable iron is obtained by following the precautions formerly mentioned, than even of caſt-iron when thus expoſed. Now, as malleable iron is free from all mixture, or at leaſt is malleable in proportion as it is unalloyed, it is obvious that the deficient weight is not made up of either oxygen or carbon. In the expoſure of one particular button of crude iron, which loſt 9½ *per cent.* the ſurface was agitated in an uncommon and moſt beautiful manner: a rapid motion from the extremity of the circumference to the centre of the fluid maſs took place; the motion ſeemed entirely rotatory, and peculiar to one common axis. The metal itſelf was of a blueiſh green colour, and emitted from its ſurface an azure-coloured gas, which preſerved a diſtinct form and colour from the common flame. This appearance firſt led me to ſuppoſe the preſence of the ferric acid, by which means the loſs of weight, when no oxyde was viſible, would be eaſily accounted for. To try, ſo far, the juſtice of this conjecture, I expoſed tin, lead, and zinc, in different alloys of theſe metals, to white heats, and found them diſſipate in a much ſhorter time, and with a greater diſcharge of gas from their reſpective ſurfaces. The ſame effect was more ſpeedily produced by introducing the pieces upon the ſurface of hot melted crude-iron. Zinc, in this experiment, inflames inſtantaneouſly; explodes with conſiderable violence, and with the diſengagement of a blueiſh flame. Its known inflammable property may add little ſtrength to this hypotheſis; but the diſſipation of lead and tin, without any reſidue, would alſo lead to a ſuppoſition of the plombic and ſtannic acids being formed by a complete ſaturation of oxygen. The latter, being found formed by nature in a cryſtalline form, does not entirely contradict this idea; for a difference in the doſe of oxygen, and of temperature, muſt alter the reſult.

metal is ſubſequently manufactured into bars, it is ſtated at different places to produce cold and hot ſhort iron.

The kidney ore will admit of a diminution of chalk, and a ſmall addition of glaſs; 1 lb. averdupoiſe of this variety will be accurately aſſayed with the addition of 5 oz. chalk, 1 oz. of glaſs, and 3-4ths oz. of charcoal. The ſame proportion of mixtures will alſo accurately reduce the ſmall pieces of this ore, commonly of a ſoft, greaſy conſiſtency, mixed with ſmall fragments of the hæmatites and kidney, and will give out the iron which they contain ſuper-carbonated. A mixture of this ſoft ore with kidney is preferred to the richer varieties at the iron manufactories. The Lancaſhire ore chiefly conſiſts of this compound, and the poorer in iron has always a decided preference given it at the blaſt furnace.

The ſtratified iron ore of the iſland of Iſlay is of moſt difficult fuſion when treated without any addition. It fuſes into a blackiſh green ponderous maſs, and, even expoſed to the higheſt heats, lets fall but a ſmall ſhare of its iron. The quality thus obtained is in the higheſt degree oxygenated; its fracture is partially cryſtalliſed in lines which converge towards the upper ſurface of the button, ſimilar in cryſtalliſation to the fracture of zinc. A regulus thus obtained, when diveſted of its ſcoria, and properly expoſed to the action of the ignited gas, ſoon loſes its fluidity, and paſſes into the ſtate of ſtrong malleable iron. If this operation is performed upon a large quantity, without agitating or turning the maſs, the upper ſurface of malleable iron will early acquire the cold ſhort quality, and will be ſubject, at the ſame time, to an uncommon waſte by the rapid oxydation of its parts. In aſſaying this ore for the production of carbonated crude iron, the reſults are obtained with conſiderable difficulty; ſeldom perfect till the ſecond or third experiment. This is chiefly owing to the great variety of quality in the ſtratum, two pieces ſeldom being alike either in appearance or in reality. The inferior maſſes yield from 44 to 48 *per cent*;

cent; and the ſuperior qualities I have found as rich as 56 to 61 *per cent.* To obtain carbonated crude iron from the richeſt varieties of this ore, add to 1 averdupoiſe lb. of it 7 ounces of dried chalk, 3 of bottle-glaſs, and 1 of charcoal. This mixture will produce ſoft crude iron, poſſeſſing great ſtrength, and an uncommonly large cryſtalliſed grain. The poorer qualities require an additional quantity of calcareous earth, to reſtore the equilibrium loſt by the ſubſtitution of ſilex in place of iron. This ore had a trial in the large way at Clyde Iron Works, but was found to yield *bad* iron with the *uſual* proportion of fuel.

Oppoſite in its quality and reſults is the beautiful ore of the iſland of Elba. This, when preſented to a requiſite proportion of carbonaceous matter, to take up its oxygen, not only clears itſelf of this hurtful mixture, but alſo takes up a conſiderable portion of carbon, which, in fuſion, becomes united to the metal, and conſtitutes it perfectly carbonated. In experiments with this ore, I found that when 2 ounces of it were treated with 2½ oz. chalk, ½ oz. bottle-glaſs, and ½ oz. charcoal, the mixture was with difficulty reduced to a white glaſs; which at no time had been ſufficiently divided to allow a general gravitation to the many globules of beautiful carbonated iron thus ſeparated. In fuſion, therefore, *per ſe*, the metal precipitated becomes greyiſh, and, in many inſtances, affords ſimilar reſults to a pure calcareous iron-ſtone; with this principal difference, that it abounds with nearly a double quantity of metal, whoſe tendency to become carbonated is no-ways inferior to any iron-ſtone of that claſs. A ſmooth carbonated regulus will be obtained from this ore, by uſing the following proportions: Ore in a raw ſtate, 2 ounces; chalk, 2 ounces; bottle-glaſs, 1½ ounce; and charcoal, ½ ounce. The ſcoria reſulting from this fuſion will be of a light-blue colour, clouded, and variegated like an agate, and very tranſparent. The great diſtance of Elba from this country precludes the poſſibility of uſing this ore in our manufactories with any

profit, unleſs it could be brought home as ballaſt, and delivered in the vicinity of any iron-work at 22s. per ton. The products obtained from it in the aſſay furnace, indicate, in an uncommon degree, how very valuable the quality of crude iron would be in the ſcale of manufacture, by its application.

The Norwegian, Daniſh, and Swediſh ores, found in ſtrata, reſemble, in many points, the Scotch ore of the iſland of Iſlay; in aſſaying them a ſimilar treatment is neceſſary. Some of them are more fuſible, and afford ſingular qualities of crude iron. When fuſed with oxygenating fluxes, the metal produced is uncommonly hard and brittle; exhibiting a fracture ſtudded with brilliant mirrors, diverging the light in ſmall radii: even when fluxes are uſed, capable of conveying carbonation, the metal exhibits this bright granulated fracture in a great degree. One of the ores from the mine of Houban, upon being expoſed a conſiderable time after ſeparation, afforded a maſs of pretty good ſteel. The proportions neceſſary to aſſay theſe, with accuracy, ſo intimately depend upon their richneſs, and the relative proportions of mixture with which the iron is combined, that the ſame recipe can ſeldom be applied to more than one variety. As iron-ſtones are more defined, and their treatment preſcribed by more certain rule, a knowledge of them will ſoon lead to a juſt comprehenſion of the primary ores; a ſecond experiment, therefore, with any of them, will be ſufficient to point out the neceſſary proportions for obtaining in the next aſſay carbonated crude iron. In one collection of Norwegian ores I found the following variety:—

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	
18	21	35	47	55	63	iron
17	16	19	11	24	19	parts volatile
65	63	46	42	21	18	earths
100	100	100	100	100	100	

This

This ſimple table will ſhew plainly how neceſſary it is to accommodate the flux to the variety of the ore. If from this collection you wiſh to obtain carbonated regulus, it is obvious that, in order to ſaturate them equally, the iron contained in No. 3 ought to be preſented with double the quantity of carbon neceſſary to carbonate No. 1; No. 5 with a triple quantity; that of No. 6 with more than $3\frac{1}{2}$: and as I have proved that this effect will be chiefly produced with the uſe of a calcareous earth, it will at once be conceived how far this ſubſtance is to be uſed as the inſtrument of alteration.

In the recipes adduced in this and the preceding paper, I have always noted charcoal as a conſtituent of each mixture. Since I diſcovered that the contact of calcareous earths conveyed carbonation to the metal, by the decompoſition of the carbonic acid, I have reduced the proportion of charcoal commonly uſed in the flux, and have, in the treatment of moſt iron-ſtones, even abandoned it altogether: however, as my experiments have not yet extended univerſally to primary ores, I have, in the mean time, retained it as a conſtituent part of the ſolvent.

XII. *On the Comparative Height of the Mountains of the Earth, the Moon, and Venus* *.

SCHROETER, the learned aſtronomer of Lilienthal, who has ſeveral excellent teleſcopes by Herſchel, publiſhed ſome time ago a work on the height of the lunar mountains, as compared with thoſe of the earth; and lately he has publiſhed a new work on the height of the mountains of Venus. Faujas, who not long ago undertook a journey into Germany, of the utmoſt importance to the ſciences, brought back with him theſe two works of Schroeter. We there ſee the manner in which that indefatigable aſtronomer makes

* From the *Journal de Phyſique, Prairial, An.* 7.

his

his observations. It is by the projection of the shadows formed by these mountains when they begin to appear on their horizon in regard to us, or when they are about to disappear below the horizon. He distinguishes the mountains into different orders.

The plate in Schroeter's work consisted only of outline, and he expressed the diameter of the three globes merely by straight lines. The annexed delineation (See Plate VIII.) was drawn by Alexander Faujas, the son, who to military talents unites a strong attachment to the sciences. He has rendered the height of the mountains more just, and, from his drawing, the respective magnitude of the three globes can be better estimated. It is here seen that the moon, which is about forty-nine times smaller than the earth, has mountains more than 4000 toises in height *; while that of Chimboraco, one of the Andes in South America, the highest mountain of our globe, is little more than 3000. Venus, which is less than the earth by a ninth, has mountains 23,000 toises in height. It must here be remarked, that the highest mountains on these three globes appear all to be volcanic.

XIII. *Description and Use of a new Portable Instrument for ascertaining the Comparative Strength of Gun-Powder. By* C. Regnier †.

In the processes employed for the improvement of gunpowder, it is necessary to make comparative experiments; and various ingenious inventions, which it is unnecessary to describe, as they are well known, have been used for that

* The French toise is to the English fathom as 1 to 1·0664.

† From *Mémoires explicatifs du Dynameter et autres Machines inventées par C. Regnier*, 4to. Paris, An. VII. The instruments here described are, 1. The dynamometer, of which a plate and description were given in the Philosophical Magazine for September 1798: 2. A safeguard for the priming in muskets: 3. The powder-proof above-mentioned; and, 4. An electrical machine.

purpose.

purpoſe. I ſhall, therefore, only obſerve, that trials of gunpowder on a large ſcale are always the beſt; but as ſuch experiments require certain kinds of apparatus and conveniences which are not always at command, a ſmall powder-proof, in the form of a piſtol, the blaſt of which drives a ſmall toothed or turned wheel that rubs againſt a ſpring, and is moved through a greater or ſmaller ſpace according to the ſtrength of the powder, has been long ago adopted and brought into common uſe. This machine, however, is very defective in regard to the reſults which it gives, and can be of no utility when an abſolute or approximate indication is required of the relative ſtrength of a given weight of powder intended for fire-arms, which are loaded with quantities determined in this manner: theſe proof-inſtruments have indeed an arbitrary graduation, and their friction varies according to the ſtrength of the ſpring and the cleanneſs of the mechaniſm.

To obviate theſe inconveniences, I made ſeveral experiments, which led me to a more valuable and accurate principle; and, with ſome variations, I at length fitted a ſmall braſs cannon to the ſpring of a common weighing inſtrument. By this application I was enabled to weigh the effort of the blaſt, and conſequently obtained a comparative method of aſcertaining its action. This inſtrument is attended likewiſe with this valuable advantage, that it acts without friction. Its graduation is accurately determined, becauſe it expreſſes the weight which ſerved for that purpoſe; and it may likewiſe be applied for weighing ſuch bodies as come within the limits of its ſcale.

A perſpective view of this inſtrument is repreſented, (Plate IX. fig. 1.) BC is a ſpring bent ſo as to form an angle; D a ſmall braſs cannon capable of containing exactly 15 grains of fine gunpowder; E the graduated arc, each diviſion of which is nearly equal to $2\frac{1}{4}$ pounds averdupoiſe, and terminating in a ſcrew that ſerves as a breech pin to the cannon. F is a cap which may be conſidered as

the

the body to be projected. It closes the mouth of the small cannon, upon which it presses with a force equal to four kilogrammes. This cap is strongly fastened to one of the spring radii by a nut at the opposite end of its tail. G is a piece of strong brass wire, fixed to a projection, which, by means of a small screw, is riveted into one of the radii. H, an index of woollen cloth or leather, which slides with a gentle friction on the wire, when the branches of the spring are pressed together by the explosion of the powder. This index remains at the place to which it has been pushed, and shews exactly how far the springs have been made to approach. When the instrument is to be used, the two extremities of the spring are to be pressed together, to separate the cap from the mouth of the cannon, into which powder is poured, till it is exactly full, by means of a card or a piece of paper. The stopper is then suffered to approach the muzzle gently, so as to close it exactly, without leaving a single grain of powder between them. The circular piece of cloth or leather, which supplies the place of an index, is to be brought into contact with that branch of the spring to which the tail of the stopper is fixed; and priming being put into the small pan of the cannon, it is discharged, the instrument being held suspended by a string or ribbon. The effects of the explosion are, that, as the powder occupies a greater space by its inflammation, it drives back the stopper, and the latter carries with it that branch of the spring in which its tail is fastened. This branch cannot move, in regard to the other, which is made to move also by the recoil of the gun, without driving before it the small index piece; and the space over which the index piece is carried will shew the force of the powder.

The arches moved over by the explosion of the different kinds of powder will shew, by the number of degrees, the comparative strength of each. A star is marked on that arch which shews the strength of powder of a mean quality; so that the relative value of any sample, in regard to that medium,

medium, may be known. The friction of the index is the only friction to which the inſtrument is ſubject; but it is ſo ſmall that it may be conſidered as of no conſequence. When the index is worn out, its place may be eaſily ſupplied by a new one. It may be readily comprehended that, by adding a hook to the perforation at the extremity of the divided arc, and a ring in the eye of the ſtopper, the inſtrument may be employed for weighing.

XIV. *Account of a Red Subſtance obſerved on the Surface of a Fiſh-Pond in Norway. By Profeſſor* H. Strom *.

In the ſpring of the year 1790, a pellicle, or ſubſtance of a red colour, was obſerved on the water at one end of a fiſh-pond in Norway, which ſoon after began to ſpread till it covered the whole ſurface. During dry and warm weather, the red colour was more perceptible than when it was cold and wet. It was more viſible alſo at noon, than in the morning and evening. I, however, did not pay much attention to it until the colour, about the end of June and the beginning of July, became ſtronger than it had ever been before; it was ſtrongeſt at noon, and always proceeded, in regular order, from the end of the pond till it gradually extended over the whole ſurface. I filled a beer glaſs with the water, which had a red appearance in the glaſs; but the red matter ſoon depoſited itſelf at the bottom, and the water became yellowiſh: for a long time, however, it had a frothy pellicle, which was ſometimes of a red and ſometimes of a green colour. I let fall a drop of this pellicle on my microſcope, and beheld the ſingular phenomenon exhibited in the annexed engraving, (Plate IX. fig. 2.) which repreſents this drop as ſeen when magnified.

* From *Tranſactions of the Society of Natural Hiſtory at Copenhagen*, Vol. I. Part 2.

I beheld partly large and partly ſmall bubbles, reſembling bright ſpecula, ſurrounded by a dark rim or margin, which were ſometimes like ſmall rings, (1,1), and ſometimes broader; ſo that the bright ſpeculum in the middle formed the ſmaller part (2,2). Every where around were ſeen an immenſe number of minute globules of the ſize as repreſented in the figure; conſequently aſtoniſhingly ſmall in regard to the ſpecula, but ſimilar to them in this reſpect, that they had a bright point like a ſpeculum in the middle. At firſt, as far as I could obſerve, they were black, or of a dark colour, the bright point excepted; but the red colour afterwards ſhewed itſelf very clearly. In thoſe that were red, the bright point was always ſeen; but this was not always the caſe with the dark ones. All theſe round bodies or globules appeared at firſt, though very ſeldom, to have ſome life and motion, but afterwards they entirely loſt all movement; and this was the caſe in particular with the red, which ſeemed entirely lifeleſs. I could alſo clearly obſerve, that the red matter, which depoſited itſelf in abundance at the bottom of the veſſel, was nothing elſe than an aſſemblage of ſuch round globules which had loſt all life and movement. Beſides theſe round globules with a bright point in the middle, I ſaw in the pellicle on the water, as well as in the water itſelf, another kind of living animals in greater numbers (3), which were ſhaped like ſmall fiſh, and perfectly ſimilar to the *Cercariæ virides* of *Müller* *, which produce the green covering on ſtagnant water; but with this difference, that they were no larger than they are repreſented in the figure, and that they had not a green but a dark appearance. I obſerved alſo, though with difficulty, that the tail was forked; and that ſome of them, cloſe to the tail, had a bright point or reflection, while the body before was not brighter than that of the *Cercaria viridis*. Theſe ſmall animals moved with great alertneſs and vivacity in the

* See his *Animalcula infuſoria*, No. 130, p. 126.

drops

drops of water; but they collected themſelves ſometimes together (5 and 6), and tumbled ſeveral times round in a circle (4). I obſerved alſo, that, when they began to loſe life and animation, their longiſh figure was changed, and they aſſumed that of a triangle or funnel, with a tail or tube (5). Müller obſerved the ſame thing in the *Cercaria viridis* *, and at laſt they acquired the form of a globule, which is repreſented alſo in Müller †. I have no doubt that theſe globules were the ſame round animals, though dead, of which I have already ſpoken; eſpecially as Müller ſays of his *Cercariæ virides*, that they can aſſume a globular form. Of the bright points in the middle he ſays nothing; and it appears ſingular to me that he did not obſerve them, as he viewed them much more magnified than I did. He ſays as little of the red colour which they can aſſume and communicate to the ſurface of the water, and nothing at all of the bright bodies or ſmall ſpecula incloſed in round rims, which were perfectly like the ſmall round globules with a bright point in the middle, only that they were ſome hundred times larger. But I dare not affirm that they were of the ſame kind, and only different in ſize. It is very probable that they conſiſted of the ſlime of the dead *Cercariæ*, which formed bubbles by means of the air incloſed in them; for, that they were round like bubbles, appears from this circumſtance, that they eluded every impreſſion, and ſometimes divided themſelves into two or more ſmaller bubbles, and even by a ſtronger impreſſion extended to a longiſh, oval, and irregular form like thoſe marked (6), which ſhews that they conſiſted of a tough ſlimy ſubſtance. Among ſome ſmall animals of another kind, ſeen ſometimes in the drops of water, none were more conſpicuous than the *Brachionus urceolaris* ‡, by its tranſparency, and the three or four round balls, or *ovaria*, which it has at the hind part of

* *Animalcula infuſoria*, Tab. 19. fig. 9.

† Fig. 7 and 13.

‡ Müller's *Animalcula infuſoria*, No. 377, Tab. 50. fig. 15. 21.

its

its body. But what diſtinguiſhed it moſt was, that, with the briſtles or hair at the fore part, it often put the water in a ſort of vortical motion, which made the ſmall lifeleſs globular animals move quickly round in a circle, as if they had been alive (7). Such was the nature of this ſubſtance for a few days in July, till it increaſed more and more; and I found, when I filled a glaſs with it, a covering on the ſurface, of the thickneſs of the finger, beſides the matter depoſited at the bottom; but no living beings were now obſerved in it, and not many of the dead globular animals: they ſeemed all to be converted into the above red ſlimy matter, the colour of which was perfectly ſimilar to that of the bright yellow ochre uſed for painting houſes.

What I have above ſaid will ſufficiently ſhew that the red colour of water, which has ſo often been a matter of terror to the ſuperſtitious, may ariſe from the innocent infuſion animals; and that animalculæ, like thoſe which I ſaw in freſh or ſtagnant water, may be found in ſalt water or the ſea, will be doubted by no one who knows that the latter has its infuſion animals alſo. We often read in books of voyages, that the ſea has ſometimes had the appearance of blood, ſometimes of ſnow or milk; and that it has even ſometimes had an appearance as if on fire. All theſe phenomena can be aſcribed to nothing elſe than the foreign matters, and particularly ſmall animals, which multiply there in immenſe quantities, and are ſometimes red, ſometimes white, and ſometimes of a flame colour, like Müller's *Trichoda ignita**, without including the *Nereis noctiluca*, and ſeveral others. It ſeems to me highly probable that, in regard to colour, they may be ſubject to different variations; as is the caſe here, from black to red, and even from red to green; as appears from this circumſtance, that the red ſkin or pellicle, after ſtanding a few days in the glaſs, was in ſome parts green. It is alſo probable that ſuch ſmall animals may ariſe from

* *Anim. infuſoria*, No. 203, p. 186.

the

the ſo called *Grönſke*, which in ſpring is ſeen in the Norwegian ſeas; eſpecially as it riſes or falls according to the heat or cold. The uncommon colour in water, which I have here deſcribed, is a remarkable phenomenon; and, during the eleven years I reſided in the neighbourhood, I never ſaw or heard of any change of the like kind in other fiſh-ponds. I therefore paid more attention to it, and eſpecially as in former times ſuch appearances were conſidered as portending wars and bloodſhed: but theſe ſuperſtitious notions muſt loſe all credit when the above explanation is adopted, and when the ſecrets of nature are more accurately explored. In regard to the cauſe of this phenomenon I muſt confeſs that to me it is inexplicable; and that it is eaſier to ſay what it is not, than what it is. It is well known that the quality of the atmoſphere, ſome years, can produce worms and inſects in incredible numbers: but what kind of weather is neceſſary for the generation of theſe infuſion animals, and whether a continual alternation of rain and ſun-ſhine, which was the caſe in the ſummer above mentioned, contributes to the phenomenon, is difficult to be determined.

P. S. The red matter continued on the water during the whole month of Auguſt, and ſeemed ſtill thicker; but the red particles were ſmaller, and ſeemed entirely deſtitute of life. The corrupted and green water below ſwarmed, on the other hand, with the *cercariæ* already mentioned; which ſometimes appeared of a triangular and ſometimes of a circular form, as already ſaid. Some green ſlime was obſerved alſo in the red matter; which however did not proceed from the latter by a change of its colour from red to green, as I at firſt ſuppoſed, but was either a ſlimy ſubſtance ariſing from the decompoſed green *cercariæ*, or ſome other corrupted ſlime, which partly kept itſelf ſeparate from the red matter, and partly mixed itſelf with it and diſappeared. At any rate, I found in it no red, but here and there a ſhrunk and wrinkled *cercaria*: but it muſt be obſerved, that what I

have, in ſeveral places, called black, may have been that dark green or almoſt black colour which M. Müller gives to his *Cercaria viridis*, and which, no doubt, would have ſhewn itſelf under a microſcope of a ſtronger magnifying power, if I had been in poſſeſſion of one at the time.

XV. *Obſervations on the ſingular Sagacity of the Rock or Ice Fox* *.

DURING my abode, ſays Steller, on Behring's iſland, I had opportunities, more than enough, of ſtudying the nature of this animal, far excelling the common fox in impudence, cunning, and roguery. The narrative of the innumerable tricks they played us, might eaſily vie with Albertus Julius's hiſtory of the apes in the iſland of Saxenburg. They forced themſelves into our habitations by night as well as by day, ſtealing all they could carry off, even things that were of no uſe to them; as knives, ſticks, clothes, &c. They were ſo inconceivably ingenious as to roll down our caſks of proviſions ſeveral poods in weight, and then ſteal the meat out of them ſo ably, that at firſt we could not bring ourſelves to aſcribe the theft to them. As we were ſtripping an animal of its ſkin, it often happened that we could not avoid ſtabbing two or three foxes, from their rapacity in tearing the fleſh out of our hands. If we buried it ever ſo carefully, and added ſtones to the weight of earth that was upon it, they not only found it out, but ſhoved away the ſtones, as men would have done, with their ſhoulders plying under them, helping one another with all their might. If, thinking to ſecure it, we put any on the top of a high poſt in the air, they grubbed up the earth at the bottom, ſo that the poſt and all came tumbling down, or one of them clambered up and threw down what was upon it with incredible artifice and dexterity. They watched all our motions, and

* From *Tooke's View of the Ruſſian Empire.*

accom-

accompanied us in whatever we were about to do. If the ſea threw up an animal of any kind, they devoured it ere a man of us could come up, to our great diſadvantage; and if they could not conſume it all at once, they trailed it away in portions to the mountains, where they buried it under ſtones before our eyes; running to and fro as long as any thing remained to be conveyed away. While this was doing, others ſtood on the guard, and watched us. If they ſaw any one coming at a diſtance, the whole troop combined at once and began digging all together in the ſand, till they had ſo fairly put a beaver or a ſea-bear under the ſurface that not a trace of it was to be ſeen. In the night-time, when we ſlept in the field, they came and pulled off our night-caps, and ſtole our gloves from under our heads, with the beaver-coverings, &c. In conſequence of which we always ſlept with clubs in our hands, that, if they ſhould wake us, we might drive them away, or knock them down.

When we made a halt to reſt by the way, they gathered around us and played a thouſand tricks in our view; and when we ſat ſtill, they approached us ſo near that they gnawed the thongs of our ſhoes. If we lay down, as if intending to ſleep, they came and ſmelled our noſes to try whether we were dead or alive; if we held our breath, they gave ſuch a tug to the noſe as if they would bite it off. On our firſt arrival they bit off the noſes, fingers, and toes of our dead while we were preparing the grave; and thronged in ſuch manner about the infirm and ſick, that it was with difficulty we could keep them off. Every morning we ſaw theſe audacious animals patrolling about among ſea-lions and ſea-bears lying on the ſtrand, ſmelling at ſuch as were aſleep to diſcover whether ſome of them might not be dead; if that happened to be the caſe, they proceeded to diſſect him immediately, and preſently after all were at work in dragging the parts away. Becauſe the ſea-lions at night, in their ſleep, frequently overlay their young, they examine, as if conſcious of that circumſtance, every morning, the whole

herd of them one by one, and immediately drag away the dead cubs from their dams.

Seeing, now, that they would not ſuffer us to be at reſt night or day, we were in fact ſo exaſperated at them that we killed them young and old, and plagued them by every means we could deviſe. When the party awoke in the morning, there always lay two or three at our feet, that had been knocked on the head by ſome of us in the night; and I can ſafely affirm, that, during my ſtay on the iſland, I ſlew above two hundred of them myſelf. The third day after my arrival, I knocked down, within the ſpace of three hours, upwards of ſeventy of them with a club. They were ſo ravenous that, with one hand, if we held to them a piece of fleſh, they would come to it, although we might have a ſtick or ax in the other to knock them on the head.

When theſe buſy animals could not get hold of what they wanted, as the clothes we put off, &c. one of them would void his excrement upon it, and all the others which paſſed would do the ſame. From all circumſtances it was clear to us, that they had had very little communication with human beings, and that the dread of man is not innate in brutes, but muſt be grounded on long experience.

In October and November they, like the other foxes, were the moſt ſleek and full of hair: in January and February the growth of it is too thick: in April and May they begin to ſhed their coats: in June and July they had only wool on them, and looked as if they went in waiſtcoats. In June they drop their cubs, nine or ten in a brood, in holes and cliffs of the rocks. They are ſo fond of their young, that, to ſcare us away, they would bark and yelp like dogs, and thereby betrayed their coverts. This mode of preſerving their young, probably, has procured them the name of ice or rock foxes. No ſooner do they perceive that their retreat is diſcovered, than, unleſs diſturbed, they drag away the young in their mouths, and hide them in a more ſecret place. On killing the young, the dam follows the ſlayer with grievous howl-

ings,

ings, day and night, for a hundred and more verſts, and never ceaſes until ſhe has played her enemy ſome trick, or is killed by him.

They ſtink much more horribly than even the red foxes. In rutting time they run together day and night, the males biting each other, from jealouſy, like dogs. When they couple, they ſcream like the cats. In ſtorms and heavy falls of ſnow, they bury themſelves in the ſnow, and lie ſtill as long as it laſts. They ſwim acroſs rivers with great agility; will ſeize the ſea-fowl by night on the cliffs when they have ſettled to ſleep; but are themſelves frequently victims to the birds of prey. Theſe animals, which are now in ſuch inexpreſſible numbers on the iſland, were moſt probably conveyed there (ſince there is no other land animal in it) from the Continent on the drift ice, and have been nouriſhed by the great quantity of animal ſubſtances thrown up by the ſea.

This ſpecies is entirely white, and their furs compoſe a conſiderable article of commerce.

XVI. *An Account of Mr.* Brown's *Travels through Egypt and Syria,* &c.

[Continued from Page 247.]

On the 28th of December 1792, Mr. Brown left Kahira to viſit Feiûm, a city diſtant about ſixty miles to the ſouth-weſt. It ſtands on the principal canal leading from the Nile to the lake Mœris, and is ſurrounded with cultivated ground producing that profuſion of roſes for which this place was celebrated, and which were diſtilled into roſe-water. The mode of propagating them was by continued layers; the young twigs thence ariſing being found to produce the largeſt and moſt fragrant flowers. The roſe-water was excellent, and ſent to all quarters; but the cultivation is now running gradually to decay: wheat and other grain abound in the vicinity.

After paſſing three days at Feiûm Mr. Brown proceeded towards the lake, of which he wiſhed to make the circuit. It is the Mœris of Strabo and Ptolemy; and the teſtimony of the latter living in Egypt ſeems unqueſtionable. However this may be, the lake now called *Birket-el-kerun*, probably from its extremities bearing ſome reſemblance to horns, ſhews no mark, as ſome ſuppoſe, of being the production of human art. The length, Mr. Brown ſays, may probably be between thirty and forty miles; the breadth, at the wideſt part he could gain, was 5000 toiſes, as taken with a ſextant; that is, nearly ſix miles. The utmoſt poſſible extent of the circuit muſt of courſe be thirty leagues. Several fiſhermen, in miſerable boats, are conſtantly employed on the lake. The water is brackiſh, like moſt bodies of water under the ſame circumſtances.

From Feiûm Mr. Brown travelled ſouth-eaſt, and at Hawâra ſaw two ſmall pyramids of unburnt brick. Returning to Bedis he paſſed, the day following, the pyramids of Daſhûr; five of which appear ſucceſſively, beſides thoſe of Sakarra. The third, after thoſe of Hawâra, is that of Medun, which has been very elegant. It is compoſed of large pieces of the uſual ſoft free-ſtone, joined together with a little cement, and has been hewn off to a ſtraight ſurface. It would be extremely difficult to aſcend to the top, which is now very broad; but it is probable that there was another ſquare completing its ſummit, which has been removed. The fourth is the moſt ſoutherly of the four pyramids of Daſhûr, where there are two large and two ſmall. It is in the form of a cone terminating in an obtuſe triangle, and is now much damaged. At Sakarra a great number exiſt, among which ten are of a large ſize *.

* Speaking of the pyramids of Jizé, well known to all who have viſited Egypt, Mr. Brown ſays: "An abſurd opinion has recently been ſtated, that the pyramids are hewn out of the rock on which they ſtand; but the firſt ocular inſpection would ſet aſide this, the joinings of the ſtones being every-where marked with cement." This is a flat contradiction of what has been aſſerted by Bruce.

On

On the 1ſt of March 1793 Mr. Brown left Kahira to proceed to Suez, which he reached after a tedious progreſs of five days. The town is ſmall, and built of unburned brick. It contains twelve moſques, ſome of which are of ſtone, but the moſt are mean buildings. The ſea near the town is very ſhallow, yet there is a ſmall yard for ſhip-building. The Arab mode of conſtructing ſhips is ſingular. They have no art to bend the timbers; none of them are crooked, except naturally ſo. They are very ſlender; and, where the upper and lower ribs join, do not paſs over one another, but by the ſide of each other. The ſea here produces few fiſh. Oyſters, indeed, and ſome others of the ſhell-kind, are ſeen: the beſt fiſh do not come higher than Coſsîr. Meat is ſcarce; bread of an inferior quality, and ſometimes hardly eatable. Butter and milk are brought in ſmall quantities by the Arabs. Water is brought from three ſeveral places. It is always bought by the ſkin, at a conſiderable price; and if a war were to ariſe with the Arabs, none could be found.

On the 8th of March 1793 Mr. Brown paſſed the ford at Suez, and on the 14th arrived at Tûr. On the 18th he left Tûr, and on the 22d, at half paſt three in the morning, reached the Monaſtery of Sinai. The convent is large, with a good garden, to which there is a ſubterranean paſſage. Within the walls is a ſmall moſque for the convenience of the Arabs. The mountain now called Sinai is high and abrupt: on the north ſide of it ſome ſnow was viſible. The whole is a very remarkable rock of red granite, interſperſed with ſpots to which ſoil has been brought by human labour, or waſhed down by rain, and in which grow almond-trees, figs, and vines. Numerous rills of excellent water guſh from various apertures in the precipice, and wander among the little gardens. Sinai has two ſummits: the higheſt, it is believed, may be the Sinai of Moſes. The weather being very clear, Mr. Brown obſerved from Mount Sinai the Eaſtern Gulph of the Red Sea, which appears very

ſmall, and more round and ſhort than is laid down in the lateſt maps. Mr. Brown returned to Suez and Kahira, without meeting any thing remarkable on the road.

Mr. Brown's views to the ſouth of Egypt having been fruſtrated the preceding year, he was reduced to the alternative of abandoning any further projects in that quarter, or of waiting for a more ſeaſonable opportunity. This ſoon occurred. He had formed a deſign of penetrating to Abyſſinia by the way of Dar-Fûr, as he was taught to believe that he might hope there for the advantages of a regular government, and, with proper management, might expect every favour from the monarch. At the moment of his return from Aſsûan to Aſſiût, the caravan of Jelabs from Dar-Fûr, called *Caſſlet-es-Soudân* *, the Soudân caravan, arrived at El-wah. It was then reported, that the ſale of their merchandize and ſlaves, of which they had no great quantity, would be completed in about two months, and that then they would return home. Their ſtay, however, was protracted during the whole winter, and in the month of March 1793 they commenced their departure from Kahira for the Upper Egypt. They were ſlow in collecting ſuch things as were neceſſary, and Mr. Brown made uſe of the time ſo allowed to procure information from various quarters reſpecting the journey.

On the 21ſt of April 1793 he ſet out from Bulak, and on the eighth day, the wind having been often unfavourable, reached Aſſiût. The firſt care was to provide camels for the route; but unfortunately they were at that time ſcarce. He, however, at length obtained five at about 13l. each. A ſupply of food was alſo procured for the journey; and the caravan having aſſembled, after about fifty days, the expected moment of departure arrived. The party having left Aſſiût on the 25th of May, encamped on the mountain above it till the 28th. On the 31ſt they arrived at

* Soudân, in Arabic, correſponds to our Nigritia, merely general words for the country of the Blacks.

Gebel

Gebel Rumlie, a high rocky mountain which they were to deſcend. It forms the weſtern ſide of the ridge, which conſtitutes, as it were, the wall of Egypt, and the eaſtern boundary of the low deſart in which lie the *Oaſes*. It conſiſts of a coarſe *tufa*, and is of rugged and difficult deſcent. They were employed four hours and a half the following morning in paſſing from the foot of the mountain to Ainé Dizé, the firſt place where water is found, and the northern extremity of the great *Oaſis*. As a hot wind blew here during the meridian hours, the thermometer ſtood at that time, under the ſhade of the tent, at 116 degrees. In marching from Ainé Dizé to Charjé, eight hours were employed. They left Charjé on the 7th of June, and on Monday the 10th arrived at Beiris. On the 13th they proceeded to Mughefs, the laſt village of the Oaſis towards the ſouthern deſart; which they left on the 15th, and on the 20th reached Seb. This place is marked by the production of a quantity of native alum, as the name imports. The ſurface near which the alum is found abounds with a reddiſh ſtone, and in many places is ſeen argillaceous earth.

Having left Seb on the 21ſt, they arrived at Selime on the 23d. On the 24th they reſted, and, continuing their route next morning, employed five days more in reaching Leghea. While they remained here, they felt much inconvenience from a ſuffocating wind, which blew from the ſouth, and raiſed the ſand in clouds. On the 2d of July the caravan left Leghea, and on the 8th, after a ſevere and fatiguing march, reached the *Bir-el-Malha*, or ſalt ſpring. The vicinity of this ſpring is remarkable for the production of *natron*, which appears under various circumſtances, and is of a quality different from that of Terané. It is very white and ſolid, and, on immerſion in water, becomes hot, and diſcharges a great portion of its air. Small quantities of it are carried by the jelabs to Egypt, where it is ſold at a high price, and is uſed principally for making ſnuff. The water found here is unpalatable and brackiſh.

They

They remained at Bir-el-Maïha till the 12th, and on the 20th encamped at a ſpot called Medwà. On the 23d they came to the firſt ſprings within the limits of Fûr, which are in this place called Wadi Maſrûk. The white ant, *termis*, was here exceedingly vexatious, building its covered way to every thing within the tent, and deſtroying all within its reach. This, together with the rains, which were now increaſing, and began to pour in a torrent through the valley, obliged them to abandon their tents, and to take ſhelter in the next village (Sweini), where Mr. Brown obtained an apartment in the houſe of Ali-el-Chatib, one of the principal merchants eſtabliſhed in the country. There he ſpent eight or ten days, and did not arrive at Cobbé, one of the towns to which the jelabs chiefly reſort, till the 7th of Auguſt. A Melek, or governor, on the part of the Sultan of Dar-Fûr, generally reſides at Sweini; and there all ſtrangers, as well as merchants of the country, coming with the caravan, are obliged to wait till the pleaſure of the monarch in diſpoſing of them be known.

As Mr. Brown had come to the country under conſiderable exceptions from the general rule of merchants trading to this country, and, in the Arabic language, rather as *Daïf-es-Sultan*, the king's ſtranger, in which light he had been hitherto viewed by the natives, he expected to obtain immediate permiſſion to continue his journey to the royal reſidence. "I obſerved," ſays he to the Melek of Sweini and other public officers, "that, intending to viſit the Sultan, I ſhould hardly have expected to be put back with frivolous excuſes, as the non-payment of duties which you dare not explicitly demand of me, and tributes, under the name of preſents, which have never yet been exacted of any ſtranger. If any duties be payable, beyond what have been already diſcharged, you are perfectly at liberty to detain all, or ſuch part of the articles I bring with me, as you may judge ſufficient to anſwer your claim, but not to refuſe me permiſſion to go to the Sultan, with whom I have buſineſs.

Or,

Or, if other reaſons operate to prevent my requeſt from being complied with, and if any ſuſpicions prevail relative to my views in coming here, I deſire, without further delay, to be furniſhed with the means of returning to Egypt, before I ſuffer, as commonly happens to ſtrangers, from the effects of the climate, while I am yet in the habit of travelling, and while the funds are yet unexhauſted which ſhould ſupport me in my progreſs farther."

The miſrepreſentations which had been made concerning Mr. Brown, and which had by this time reached the Sultan, manacled the hands of the Melek, and prevented his remonſtrance from having any effect. Finding, therefore, no mode of advancing till the reſt of the caravan ſhould obtain the ſame permiſſion, he reſolved to follow the example of the other jelabs, and wait patiently the event. At length, after the expiration of about ten days, an order from the Sultan arrived, directing that all the jelabs ſhould be allowed to proceed to their houſes on paying the duties aſſeſſed on them.

Before leaving Kahira, Mr. Brown had been appriſed that all commerce in Dar-Fûr was conducted by means of ſimple exchange. To carry on this, in ſuch a way as not to be groſsly defrauded, he was induced to ſeek for a perſon who might go through this buſineſs for him, at leaſt with ſome ſhare of probity. The perſon recommended to him for that purpoſe had been a ſlave-broker in the market of Kahira; and though Mr. Brown expected from him that ſubmiſſion and obedience for which the lower claſſes of the Kahirines are, externally at leaſt, remarkable, he was diſappointed in his expectations. The letters with which he was provided for different merchants in this diſtrict, under whoſe roof he might have had a ſafe lodging, could be of no uſe till he had ſeen the Sultan; for, till then, no perſon knew in what character to receive him. The object of this man, therefore, was to prevent his introduction to the Sultan, and to preclude him from any opportunity of repreſenting his caſe,

caſe. They were no ſooner arrived at Sweini than he found means to employ one of his aſſociates, who had been ſome years eſtabliſhed in the place, to go to the monarch and infuſe into his mind ſuſpicions of him as a Frank and an Infidel, who came to the country for no good purpoſe, and whoſe deſigns it behoved him to guard againſt. The villain himſelf was in the mean time not idle. As the houſe in which Mr. Brown lodged had no doors, he took advantage of this circumſtance, and his momentary abſence, to ſecrete from a box, which he had broken on the road, a quantity of red coral. By the help of this commodity, Mr. Brown had expected to make his way to the Great. At the end of a few days, this agent returned, bearing a ſpecious letter impreſſed with the Sultan's ſeal, ordering that no officer on the road ſhould preſume to detain him, or take any thing from him, till he came to the houſe of *Ibrahim-el-Wohaiſhi* (the name of this very agent) in Cobbé, where he was to reſt himſelf till further orders. In this ſituation, ſeeing no means of immediate relief, Mr. Brown began to feel impatience, which, as he continued in a ſtate of inactivity, communicated the more rapidly its pernicious influence to his health. On the fourteenth day he was attacked by a fever, attended with extreme pain in the head. How long it laſted he could not tell, having loſt his recollection on the ſecond day. It was afterwards recalled by the effect of a dyſentery, which laſted for two days, and left him too weak to aſſiſt himſelf.

A little more than a month elapſed, when, the ſymptoms appearing to diminiſh, he again preſſed to be permitted to viſit the reſidence of the Sultan. But he had reaſon to regret his impatience; for, having at length obtained leave, he proceeded to El Faſher only to repeat his ſufferings. When he arrived at El Faſher, he was firſt introduced to the Melek *Miſellim*, one of the principal miniſters. He received him with a rude ſtare, as an object he was unuſed to, which was followed by a ſmile of contempt and averſion.

He

He was ſeated, with ſome more of the royal attendants, under a kind of awning of cotton cloth, on a mat ſpread upon the ſand. After the common ſalutations, the Melek and his company entered into converſation on the nature of his viſit to the country; while each made remarks on his perſon, and offered conjectures as to his character and intentions. At length a wooden bowl of *polenta*, and another of dried meat, were ſet before them. Mr. Brown's illneſs deprived him of all inclination to eat, and, obſerving the company not much inclined to invite him to join them, and yet embarraſſed to avoid that ceremony, he relieved them by declining it, and deſiring them to begin. When they were ſatiated, a great number of fooliſh queſtions were aſked him about Europe; ſome of which he waved, and ſatisfied them as to others in the beſt manner he could. When he obſerved that they grew tired of aſking queſtions, he ſeized the opportunity of explaining why he came there, and what favour he expected would be ſhewn to him. "Melek," ſaid Mr. Brown, "having come from a far diſtant country to Miſr (Kahira), I was there made acquainted with the magnificence, the extended empire, and, above all, the juſtice and hoſpitality of the king Abd-el-rachmân. Having been uſed to wander over various countries as a *derwiſh*, I grew deſirous of ſeeing Dar-Fûr. I was told that my perſon and property would be ſecure: but ſince my arrival within the confines, I have found all theſe aſſurances fallacious; my inclinations have been thwarted, my perſon treated with indignity, and my property plundered. I aſk redreſs—I deſire the puniſhment of the man who has robbed me, and reſtitution of what has been taken. Nor is this all; I particularly deſire permiſſion to go to Sennaar, in order to proceed to Habeſh. I was prevented from going there laſt year by the ſtraight road. Habeſh is a Chriſtian country, abounding in ſlaves and gold: there are alſo many herbs valuable in medicine. Being there, I may eaſily join my countrymen, merchants who come to

Mocha,

Moccha, in the Bhar Yemeni. I desire the Sultan will allow me to proceed thither; and, if it be necessary, grant me his protection, and three or four persons, deserving confidence, to attend me to the frontiers of Kordofân. I have a small present to offer him, consisting of such things as my circumstances permitted me to bring. I hope he may not refuse to receive it, and to grant me the favour I ask."—He answered: "Merchant, you are welcome to the *Dar*. The king is kind to strangers, and he will favour you in all you wish. Whatever you want, you have only to demand. He has ordered a sack of wheat and four sheep to be sent you. At this time it is not possible to pass through Kordofân: the Sultan has a great army there; and when the country shall be in subjection to him, you may pass unmolested. When you are admitted to his presence, you will tell him who has robbed you, and what you have lost; and he will cause it to be restored." It was now the hour of prayer, and, when the company commenced their ablutions, Mr. Brown retired.

[To be continued.]

XVII. *On the Disappearance of Swallows in Autumn; in a Letter from Mr.* PETER COLE *to Dr.* MITCHILL, *dated New-York, September 25, 1798* *.

IN consequence of the epidemic now raging in this devoted city, I have not had an opportunity to give you a detail of what I intimated to you some time ago relative to the disappearance of swallows.

In my early years, a number of my school-companions and myself used to make it a practice to hunt what we termed Ground-Swallows (*hirundo riparia*), in a bank in the neighbourhood of this city, contiguous to where the Jews burial-ground then was. In one of these boyish amusements I recollect two gentlemen passed nearly by us,

* From the *American Medical Repository*.

who ſtopped and examined the birds we had dug out of the hill; whereupon a converſation took place relative to the migration of the ſwallows. The gentlemen both agreed that they were preparing for their winter quarters; and one of them farther added, that he ſuppoſed that numbers of them kept in a meadow cloſe by. Theſe obſervations made ſuch ſtrong impreſſions on my mind, that they have never ſince been eraſed.

After our revolutionary war was over, and my return again into this city in 1783, in order to be convinced of the truth on this curious and controverted ſubject, I made it a practice to walk around the Collect *, mornings and evenings, in the ſeaſons when they aſſembled, in order to mark their flight or return again; but could not diſcern any thing material until the 3d inſtant. As I was ſtanding at my door between the hours of five and ſix in the morning, I obſerved a very large flock of ſwallows flying in an eaſterly direction. I immediately repaired to the pond, where there was already a vaſt number collected in the reeds and ruſhes. They continued coming for nearly the ſpace of half an hour, and vaſt numbers of them were flying over the water in almoſt every direction. Some of theſe birds appeared to run on the ſurface of the water with great rapidity towards the eaſt corner of the pond, and, in the twinkling of an eye, diſappeared under the water and roſe no more.

They ſeemed to crowd principally towards that particular ſpot. But what is ſomewhat remarkable, and deſerves particular notice, is, that among them I obſerved a number of white ones intermixed with the reſt. While I was ſtanding on the edge of the pond with my ſpy-glaſs, Mr. Brooks, a particular acquaintance of mine, who lives near the place, came towards me. I mentioned my errand to him. He ſtood with me a conſiderable time, and ſaw the ſame. I obſerved to him that there were white ones among them.

* A pond of freſh water adjoining a marſh in the vicinity of the city of New-York.

He

He replied, that they were seen three or four days ago. His word may be relied on as a man of strict honour and integrity.

Thus, Sir, I have given you a short sketch of what has come within my own knowledge, and what I earnestly wished to discover. I hope I shall not intrude upon your patience if I subjoin an extract from the Christian's, Scholar's, and Farmer's Magazine *. It runs thus:

"*February* 23, 1790. In Ulster county, in the state of New-York, on an island in the Never-Sink-Creek, nearly in the latitude of 41° 30′ north, a Mr. Baker, in the beginning of the month of March last, having cut down a large hollow beech-tree, to his surprise found the cavity in the tree nearly filled with the common barn-swallows (*hirundo rustica*) of this country, in quantity (by his estimation) nearly two barrels: they were in a torpid state; but carrying some of those which were not injured by the fall of the tree near a fire, they were presently re-animated by the warmth, and took the wing with their usual agility."—This may be depended on as a fact.

I take the liberty also to mention another relation from the American Museum †. It is taken from Mr. Josiah Blakeley's letter to Mr. Carey, dated Baltimore, January 7, 1788. As the piece is of considerable length, I shall only quote a few passages from it. He begins thus:

"The history of our common swallows has long been a problem in ornithology. Whilst people in general supposed them birds of passage, a few, who appear to be better informed, supported the contrary. The opinion of the many was founded on what they thought probable; that of the few on facts. In the year 1780 I was conversing with a person, who lived about twenty miles from Boston, on the phenomenon of the sudden exit but gradual and irregular return of swallows. The gentleman to whom I made these

* Volume the Second, page 735.

† Volume the Third, page 451-2.

remarks,

remarks, replied, that they were not birds of paſſage; and the cauſe of their ſudden diſappearance, but irregular return, was, they had a fixed day for immerging in the water, but none for emerging from it. On my doubting his hypotheſis, he told me, that as a neighbour of his, not long before, was draining a pond, on a warm day, near the ſeaſon of the year in which the ſwallows firſt appear, his attention was attracted by obſerving the mud, which, in conſequence of draining the pond, had for ſome time been expoſed to the ſun, move and appear animated; he then ordered a quantity of this mud to be conveyed into a room in his houſe, which he cauſed to be gradually warmed by a ſlow fire. From this mud there ſoon aroſe a number of ſwallows, hovering over himſelf and family, who had been ſpectators of their reſurrection.

Theſe few obſervations, however imperfect, may poſſibly afford a large field for ſpeculation to the philoſophic mind, and lead to uſeful diſcoveries. For my own part, I am now become a proſelyte to the doctrine of the ſwallow's remaining in a torpid ſtate during the winter, not only from ſpeculative reſearches, but from ocular demonſtration *.

XVIII. *Meteorological Obſervations made at Padua in the Month of June* 1783, *with a Diſſertation on the extraordinary Fog which prevailed about that Time. By* M. Toaldo †.

Barometer.—Its greateſt elevation was on the 24th and 25th of the month, *viz.* 28 inches 4 lines; its greateſt depreſſion on the 16th, 27 inches 4 lines. In the ſummer months there is generally very little variation in the baro-

* Pennant, in his Britiſh Zoology, Vol. I. p. 414, feels diſpoſed to ſmile at the accounts given by Olaus Magnus, Derham, and Klein, of the ſubmerſion of ſwallows. Let the phyſiologiſt and anatomiſt reaſon on the matter as they may, there ſeems to be poſitive evidence of the fact. *E.*

† From the *Journal de Phyſique.*

meter, and it remains almoſt always ſtationary. It appears that it roſe very much after the fog, of which I ſhall ſoon ſpeak.

THERMOMETER.—The month, in general, was cool: its mean heat, which commonly is 19 or 20 degrees, was this year only $16\frac{1}{2}$; for in the latter part of the month the thermometer did not riſe above 22·6, and in the beginning it was at 10. I ſhall obſerve that it fell four degrees between the 16th and 17th, owing to a ſtorm which came on.

HYGROMETER.—Notwithſtanding the rain, it always pointed to dryneſs; which proves the exaltation of the vapours.

RAIN.—If we conſider the days when it rained little or a great deal, we ought to ſay that the month was extremely rainy, for it rained twenty-two days: but the rain in general was not abundant, as there fell two inches leſs of water than uſual. This obſervation is applicable only to the level country; for in the mountains the rain was exceſſive, and occaſioned a very great ſwell in the rivers and torrents.

But there occurred two particular phenomena to be obſerved, *viz.* the fog and thunder. On the morning of the 18th, after a ſtorm, which had been preceded by ſeveral others, the ſun appeared extremely pale through a light fog, which filled the whole atmoſphere. This fog became ſtill more condenſed the following days; and was not diſſipated by the winds, nor even by the ſtorm of the 26th in the morning, accompanied by a great deal of thunder, which was heard all along the direction of the mountains from one ſea to the other. This fog ſtill exiſted in the beginning of July, and ſeemed to become thicker, at leaſt at certain hours. It did not prevent the ſun or ſtars of the firſt magnitude from being ſeen, except in the lower part of the horizon. People could look at the ſun without being incommoded, and without uſing coloured or ſmoked glaſs. It appeared of different colours, according to the kind of rays which the difference in the denſity of the fog ſuffered to paſs. As the

yellow

yellow and red, being the ſtrongeſt, were thoſe which pierced it oftenеſt, the ſun appeared like a ball on fire, or of a blood colour; which gave occaſion to many whimſical people, whoſe imaginations were heated, to ſee there, as in the clouds, the figures of men and animals. Very often the ſun, in the higher part of the atmoſphere, ſeemed pale and white by the abſence of ſeveral coloured rays; and he appeared red when he was lower, becauſe his rays then paſſed through a greater portion of the atmoſphere.

That it may not be imagined that this phenomenon is new in the world, I ſhall here give a ſhort account of thoſe obſerved formerly, analogous to it. But it will firſt be proper to ſay a few words reſpecting the cauſe of this extraordinary fog, which I am inclined to think came from Sicily and Calabria, where there were violent earthquakes. We know, by the accounts given, that the heavens in thoſe countries appeared cloudy after the great ſhocks, which may be readily believed when we conſider the immenſe exhalations that muſt have been diſperſed throughout the atmoſphere. In the month of June the ſouth-eaſt winds prevailed throughout all our country. Theſe winds at Venice are called *Foriani*, becauſe they firſt take place on this ſide of the gulph. It is very probable that theſe winds, traverſing that part of the atmoſphere, may have carried with them a large maſs of exhalations, which, being ſtopped by the chain of the Alps, diſperſed themſelves in Lombardy, and occupied even the Alps, which people, with aſtoniſhment, beheld red, or of different colours, according to the poſition of the ſun and of the obſerver. It does not appear that theſe exhalations aroſe from our territory, which was not ſeen to ſmoke, as is generally the caſe in the time of a fog; but it proceeded downwards, as if it had fallen from the atmoſphere. It was not ſeen to touch the earth, except when, by an optical illuſion, the nebulous ſtratum, by being lengthened, appeared united with the ſenſible horizon. It occaſioned no hurt, therefore, to the fruits of the earth; it is ſaid only that it blaſted the olives

and vines a little on the elevated grounds. If any ſuffered in the flat country, the cauſe may be aſcribed to the rains which took place at the time when they were in bloom.

If this fog aroſe, as I have ſaid, from exhalations diſengaged at the time of earthquakes, it muſt have been dry, and muſt have contained abundance of earthy, fiery, mineral particles, with a great deal of inflammable air and electric fire. To theſe may be aſcribed the frequent thunder which took place, eſpecially towards the middle of the month. The thunder in general made dreadful ravage, burning houſes and deſtroying men and animals. Letters from Hungary ſtate, that, after ſeveral ſhocks of an earthquake, the city of Kremnitz was ſet on fire by lightning. The ſame fate was apprehended for Vicenza on the morning of the 26th, the repeated claps of thunder being ſo violent. Five or ſix houſes were that day ſtruck by the lightning, which occaſioned conſiderable damage. The lightning fell alſo in about a dozen of places in the neighbourhood, particularly in the mountains.

I ſhall here ſubjoin a ſort of chronicle of the periods when the ſun was ſeen obſcured by fogs; and I am perſuaded that many other inſtances might be found in different authors. This notice will ſerve to baniſh every thing marvellous in regard to the fog of 1783; and to ſhew that nothing happens at preſent which has not happened formerly, and even attended with more diſagreeable circumſtances.

Epochs of the Sun being darkened, and of other ſimilar Phenomena.

Years of Rome.

291 The ſun darkened; a comet; fire in the heavens, (that is to ſay, an *Aurora borealis.*) *Julius Obſequens de Prodigiis.*

542 Sun redder than uſual, being of a blood colour.

552 The diſk of the ſun appeared ſmaller.

554 In the kingdom of Naples, the weather being ſerene, the

Years of Rome.

the ſun appeared of a blood colour, and the heavens as if on fire, (that is to ſay, an *Aurora borealis*.)

710 Among the prodigies obſerved during the year of Cæſar's death, is reckoned that of the ſun being darkened, and appearing red.

Cùm caput obſcurâ nitidum ferrugine texit,
Impiaque æternam timuerant ſæcula noctem.

Julius Obſequens relates at more length the prodigies which appeared; particularly torches ſeen in the heavens, and crowns ſurrounding the ſun, which for ſeveral months ſeemed to emit only a pale feeble light: People, therefore, could look at his diſk.

Years of the Chriſtian æra.

264 A great earthquake, and darkneſs for ſeveral days.—*Friſtchio.*

396 At Conſtantinople there were ſuch extraordinary ſtorms that the earth ſhook, while the heavens ſeemed on fire. At that period people expected the end of the world.

790 And, according to others 798. For ſeventeen days the heavens afforded no light. This phenomenon was preceded by earthquakes in Candia and Sicily.—*Collect. Acad. de Lancil. Friſtchio.*

937 The heavens being ſerene, the ſun was darkened; and his rays, paſſing through the windows, ſeemed bloody.

1020 The moon appeared of the colour of blood, and flames fell from the heavens like a tower, (that is to ſay, a conſiderable thunderbolt, or globe of fire like a carcaſs or bomb full of grenades, ſuch as is ſaid to have been obſerved this year (1783) at the cathedral of Liege. If I am not miſtaken, Scheuchzer of Berne relates that he obſerved one). According to hiſtory there were other cataſtrophes: the ſea left its bed, and inundated

Years of the Chriſtian æra.

ſeveral places in the neighbourhood. The ſame thing happened during the hurricane of March 11th this year (1783).

1104 The ſun and moon in diſorder were eclipſed ſeveral times, (that is to ſay, were obſcured:) there were ſeen falling ſtars, flaming fires, fiery meteors, lightnings, hail; typhons and hurricanes took place, which overturned churches and houſes; deſtroyed men, cattle, and plants; and occaſioned great devaſtation in the fields. This is exactly what happened in 1783.

1154 On the 1ſt of October, the ſky, being ſerene, appeared all of a ſudden quite darkened.

1206 People imagined that they ſaw in the heavens a human head; and the following year, in Germany, the ſun ſeemed divided into three parts. Similar phenomena may eaſily deceive the imagination of men, which is generally confuſed during ſuch events, as was obſerved in 1783.

1227 An earthquake and comet—the ſun of the colour of blood.

1263 The ſun obſcured, without any clouds, in ſuch a manner as not to give any light.

1383 An earthquake in Swiſſerland. A large circle afterwards around the ſun for ſeveral days.

1549 There appeared in the afternoon, for three days in April, a globe all on fire. It is even ſaid, that armies had been ſeen fighting in the heavens before, and two lions engaged. (Theſe were the ſportings of the light of an *Aurora borealis*.)

XIX. *Observations on Pumice Stone, and the Places where found.* By *Professor* BECKMANN *.

PUMICE ſtone, *pumex*, *pierre-ponce*, *pomice*, is a porous, light, friable, rough kind of ſtone, which floats in water; neither ſtrikes fire with ſteel, nor effervesces with acids; contains little or no iron, but ſometimes more, ſometimes leſs magneſia; and, in a ſtrong heat, becomes fuſed to glaſs without the addition of any other ſubſtance. On account of its ſingular properties, an idea was entertained, even in the moſt ancient periods, that it muſt have originated in a different manner from other ſtones. As it was found in many parts floating on the ſea, the ancients conſidered it to be a kind of hardened ſea-ſcum; as from the ſame ſuperficial grounds the bones of the cuttle-fiſh, employed for many purpoſes like pumice ſtone, are called ſea-ſcum alſo. More attentive obſervers, however, perceived that it was indebted for its formation to the force of fire; eſpecially as it was found, for the moſt part, near volcanoes, and was actually thrown up by them.

It is now known with certainty, that real pumice ſtone is a volcanic production, both that thrown up by the ſea, and that found even in Germany, where there are no burning mountains. The latter kind is a proof that in theſe diſtricts there muſt formerly have been volcanoes; and the former, of volcanoes ſo near the ſea that their eruptions could reach it. No place, however, abounds more with this kind of ſtone than the Lipari iſlands, particularly Lipari and Vulcano, from which, ſince the earlieſt periods †, all Europe has been ſupplied with this ſtone, and chiefly by the

* A chemical examination of it may be found in Cartheuſer's *Mineralogical Eſſays*; Bergmann's *Opuſcula*, III. p. 197; and Achard's *Collection of Phyſical and Chemical Eſſays*, I. p. 58.

† Pumices laudatiſſimi ſunt in Æoliis inſulis. *Plin. Hiſt. Nat.* lib. xxxvi. cap. 21.

Sicilians. Of theſe iſlands we ſhould have known little more than what has been told us in the fables of the poets, had they not been viſited, in the year 1781, by Dolomieu, who publiſhed a mineralogical deſcription of them *; for all other travellers who have given accounts of Sicily ſay nothing of them, partly becauſe they followed the common routine, and wiſhed to ſee only ſuch objects as had been ſeen by others—and partly becauſe theſe iſlands lie in a tempeſtuous ſea, where to the danger of ſhipwreck is added that of being taken by the Barbary cruiſers, who hover about in that neighbourhood during the whole ſummer. Travellers, however, who wiſh to ſee more than antiquities, and who are deſirous to examine and deſcribe more than things already known, may here expect a rich harveſt, if they are accuſtomed to make obſervations in regard to natural hiſtory: for objects worthy of their notice cannot be wanting in iſlands where volcanoes of every kind exiſt, ſome continually burning, and ſome which, like Ætna and Veſuvius, are ſometimes at reſt, and ſometimes in a ſtate of violent eruption; where there are others totally extinct; and beſides theſe, lava of all kinds, and in each degree of calcination, vitrification, and efflorescence †.

The Lipari iſlands, the *Inſulæ Æoliæ* or *Vulcaniæ* of the ancients, lie between Italy and Sicily, but nearer to Sicily, from the coaſt of which the neareſt is diſtant about thirty Italian miles. Dolomieu makes the number of them to be ten; others ſay there are eleven. The largeſt, which is the moſt fertile and beſt peopled, is called Lipari. It is eighteen Italian miles in circumference, and contains a

* See his Voyage to the Liparine iſlands. Compare alſo *Viaggi alle due Sicilie e in alcune parti dell' Apennino, dall' Abbate Laz. Spallanzani.* Pavia, 1793, 8vo. tom. ii.

† In regard to the preciſe ſituation of theſe iſlands, ſee Homan's map: *Sicilia, Sardinia, Corſica, Malta,* 1762, conſtructed by Zannoni. On the the three-ſheet map publiſhed by Loller in 1770, under the title of *Mer Mediterranée*, the iſland of *Uſtika* is entirely omitted.

ſmall

ſmall town of the ſame name. According to Dolomieu, it is the inexhauſtible magazine from which all Europe obtains pumice ſtone; and it has whole mountains of that ſubſtance, in which large holes have been cut without any perceptible decreaſe being obſerved. Next to Lipari, and neareſt to Cape Melazzo in Sicily, lies Vulcano, nearly twelve Italian miles in circumference, and ſeparated from the former by a channel only one Italian mile in breadth. Its fire is never extinguiſhed; and it contains an inexhauſtible ſtore of pumice ſtone, which has a perfect reſemblance to that of Lipari. Some of it is collected for foreign trade; but this uninhabited iſland is viſited, at preſent, merely on account of its wood, which grows on the ſouth ſide of an ancient crater.

The pumice ſtone, however, of theſe iſlands, is very different in regard to ſolidity, hardneſs, and weight; and it may be diſtinguiſhed into four kinds, one of which only is employed in foreign commerce. The firſt is grey; has a cloſe grain, imperceptible interſtices and fibres; a conſiderable weight; great compactneſs; and ſomewhat of a vitreous fracture. This ſtone, which can be eaſily cut, is employed as corner-ſtones for buildings, and for all kinds of walls in general. The town of Lipari is almoſt entirely built of it.—The ſecond kind is alſo grey; but lighter, more porous, and has more perceptible fibres than the former, and does not float in water. It is uſed for arches; and on that account great quantities of it are carried to Sicily and Naples.—The third is light, porous, and full of fibres; it floats in water; has a ſilky appearance on the fracture; and is compact and of a hard grain, which renders it exceedingly proper for poliſhing marble and metals. This is the only kind employed in foreign trade.—The fourth kind is exceedingly white; of a very tender texture, and leſs compact than the others. It ſeems to have reached the utmoſt degree of extenſion, to which any ſubſtance can attain, for its parts to retain a connexion. This kind is fit for no pur-

poſe whatever. When it falls into the ſea, it floats often to a great diſtance; and it may be found ſometimes on the coaſt of Sicily and Calabria *. It is in general remarked, that the whiter pumice ſtone is, it is always the lighter †.

The moſt common uſe of this kind of ſtone is for poliſhing almoſt every kind of ſubſtance; and it is exceedingly proper for the purpoſe, as it is ſoft enough to be rubbed to a fine powder; and yet its fineſt particles remain ſo rough that they can attack and wear down the ſurface of bodies without making ſcratches. The powder of vitreous ſtones would alſo rub off particles by friction, but, on account of its acute edges, would leave ſcratches; and to pound it ſo fine as to prevent this inconvenience, would require much more trouble and time than the pumice ſtone; and even then, this fine powder of vitreous ſtones would ſuffer itſelf to paſs over the bodies to be poliſhed almoſt like argillaceous earth, without making any impreſſion upon them. The workmen, who employ pumice ſtone for this purpoſe, uſe it either pounded, ſifted and waſhed, or in whole pieces, as the hatmakers, curriers, and ſome workers in metal. The laſt muſt chooſe ſuch pieces as have fine pores, and are ſo large that they can aſſume the form proper for rubbing or ſcowering. On this account preference is given, in commerce, to that kind of pumice ſtone which does not conſiſt of too ſmall pieces. In general, it muſt be light, rough, friable, of a grey colour, and free from ſand or any other foreign

* Popowitſch, in his *Reſearches reſpecting the Sea*, p. 347, obſerves, that this pumice ſtone is caſt by the weſt wind on the Calabrian ſhores, and by the north wind on thoſe of Sicily and Greece. He was told there that it was a ſubſtance thrown up by the volcanoes of the Lipari iſlands. But it may be ſeen, by Dolomieu's account, that it never can be an article of commerce, as Popowitſch thinks.

† Cronſtedt ſays, in his *Mineralogy*, that the white pumice ſtone is produced from the black by its being bleached in the open air. But this is not the caſe: the white is of that colour when it is thrown up. See Olafſen's *Reiſe durch Iſland*, ii. p. 103. Linnæus, therefore, has been guilty of an error in his *Syſt. Nat.* iii. p. 181.

parts.

parts. When it is to be employed as teeth-powder, it muſt be pounded remarkably fine; and even then it will attack the teeth too ſtrongly.

In countries where pumice ſtone can be procured at a cheaper rate than among us, it is pounded and mixed with the mortar uſed in building. This is done in Italy *; and the caſe muſt have been the ſame in former times, as pieces of it are frequently to be obſerved in the mortar of ancient walls. It has this binding property in common with terras, pozzolana, and other volcanic productions. From this circumſtance we might be induced to conjecture, that the ancients mixed fine *terra ſigillaris* with pumice ſtone coarſely pounded, and formed it into moulded maſſes, which they dried in the ſun, in order to make thoſe bricks for building, which, as Strabo, Pliny, Antigonus Caryſtius, Vitruvius, and others †, tell us, with ſome degree of wonder, ſwam in the water; and that, on account of their lightneſs, they were peculiarly well adapted for many uſeful purpoſes. They expreſsly ſay, that the ancients uſed, in making them, the mineral employed for cleaning ſilver-plate, which we may conſider to have been pumice ſtone; though many other kinds of earths are fit for the ſame purpoſe. This conjecture has given riſe, in modern times, to experiments which have not yet been attended with complete ſucceſs. It will be difficult, indeed, to obtain bricks ſo light by mixing clay with finely pounded pumice ſtone, as it will then form a body too compact and heavy. From a paſſage in the Travels of Peter Della Valle ‡ one might be induced to conjecture, that the art of making ſwimming bricks was known at Ormus, an iſland in the Perſian Gulph, unleſs he meant perhaps to ſay that pumice ſtone was employed there for building as in

* Labat's *Reiſe durch Italien*, iv. p. 16.

† The teſtimonies of the ancients on this ſubject I have given in a note to the *Hiſtoriæ Mirab.* of Antigonus Caryſtius, cap. clxxxvii. p. 228.

‡ Della Valle's Travels. Geneva, 1674. fol. 3. p. 239.

Sicily;

Sicily; but in Sicily the heavy kind of pumice ſtone, which does not ſwim, is employed for that purpoſe. It is worthy of remark, that among the ſo-called Etruſcan and other earthen ware, as well as among thoſe which were formerly brought from Japan and China oftener than at preſent, there were veſſels much lighter and thinner than any that can be manufactured in Europe. It is not improbable that Fabbroni may have been ſo fortunate as to diſcover this preparation: at any rate, he not long ago laid before the Economical Society of Florence, for examination, a kind of brick, the ſpecific gravity of which was not greater than that of the lighteſt wood *.

Moſt authors, who give an account of pumice-ſtone, ſpeak of it as if it were to be found in the neighbourhood of all burning mountains. This, however, is falſe; for it is not found among the productions of all volcanoes, but only near thoſe, as the mineralogiſts aſſert, the fire of which has ariſen in ſuch ſtrata as have intermixed with them a great deal of feld ſpar. It is found nowhere in greater abundance than in the Liparine iſlands, as already ſaid, though large quantities of it are found in Iceland; whereas it is very ſeldom ſeen near Veſuvius, and never in the neighbourhood of Ætna. The ancients, however, ſpeak of Ætnean pumice-

* After I had written this article, I found in Gren's *New Phyſical Journal*, Vol. II. part 2. p. 129, a paper tranſlated from the Italian of Fabbroni, by which it appears that he made his brick of a kind of earth dug up near Santa Fiora, in the territories of Sienna, which neither effervefces with acids nor is fuſible in the fire, and which, according to his examination, conſiſts of ſiliceous earth, magneſian earth, and aluminous earth, in the proportions of 0·55, 0·15, and 0·12. This earth, therefore, ſeems to conſiſt of the ſame component parts, and almoſt in the ſame proportions as the ſo-called ſea-froth. According to the prevailing mode of changing old names and making new ones, Fabbroni calls the above earth *Farina foſſilis*, under which is underſtood, at preſent, an earth ariſing from efflorefced gypſum.

[For Fabbroni's method of making floating bricks, ſee *The Philoſophical Magazine*, Vol. II. p. 180. Edit.]

ſtone;

ſtone; for example, Cornelius Severus, the author of a poetical deſcription of that mountain. Theophraſtus ſpeaks alſo of the pumice-ſtone of Ætna, which he deſcribes as black and heavy *. Under this head we may place the *Catinenſis pumex* of Juvenal †, though this phraſe will admit of another explanation; and perhaps the poet meant only to indulge in a little occaſional raillery againſt the celebrated voluptuaries of Catina or Catana. I well know that we cannot expect from poets, in general, the accuracy which muſt be obſerved by naturaliſts; but thoſe who conſider the paſſage as admitting of no doubt, may ſupport it by the teſtimony of Gioeni ‡, who found pumice-ſtone, perfectly like that of Lipari, in the neighbourhood of Ætna, during the eruption of 1787; but he adds, that nothing of the kind had ever been found near Ætna before.

XX. *Eighth Communication from* Dr. THORNTON, *Phyſician to the General Diſpenſary, relative to Pneumatic Medicine.*

CASE OF PARALYSIS CURED BY THE INHALATION OF VITAL AIR.

MR. HUITSON, who diſſects for Mr. Cruickſhank and Mr. Wilſon, eminent teachers in the ſchool of the late Dr. Hunter, had a paralytic affection of the right hand, which deprived him of its motion, and it felt to the other hand al-

* See the faulty German tranſlation of his work on ſtones, § 40. p. 120. I ſhall here occaſionally obſerve, for the ſake of thoſe who are fond of comparing the accounts of the ancients and moderns, that a kind of *traſs* was employed for mill-ſtones in the time of Theophraſtus and Strabo. Ἔστι πέτρα ῥαδὴς γινεται λίθος μυλίας. Strabo, Lib. VI. p. 413. The ancients were acquainted alſo with the uſe of that kind called by Cronſtedt the Rheniſh mill-ſtone; a good deſcription of which has been given by Collini in *Journal d'un Voyage*, Manheim 1776. 8. p. 301. Compare alſo my *Phyſikaliſch-Oekon. Biblioth.* Vol. VII. p. 455 and 519.

† Sat. VIII. 16.

‡ See *Von Salis's Collections towards a Natural Hiſtory of the Kingdom of the Two Sicilies*, 1790. 8. I. p. 172.

ways

ways remarkably cold. The paralyſis ſeemed chiefly ſeated in the muſcle of the thumb. I adviſed him the trial of electricity; and we obſerved, as well as thoſe who accompanied him, that the electric ſpark did not fly with a crackling noiſe to the paralytic muſcles. Trying a piece of dead meat we found the ſame phenomenon. We then had recourſe to inhalation of vital air mixed with atmoſpheric, and he inhaled from ſix to eight quarts vital air. The muſcle, now receiving oxygenated blood, afterwards caught the electric ſpark very readily, and a genial warmth was diffuſed throughout the paralytic hand. This was not a ſolitary obſervation, but conſtant; and it ſeems to me very forcibly to prove the animating principle derived from the oxygen of the air to the muſcular fibre; a principle not, as repreſented by Mayow, the moſt ſubtle, ſpiritual, and ætherial, but one that can be made obvious to our ſenſes in the form of air, adhering to the calces of metals, and capable now of being conceived even by the moſt groſs underſtandings.

The patient, I am happy to add, by this *combination* of external and internal ſtimulants, was completely reſtored, and has continued many months perfectly well.

As the caſe is ſhort, I will ſay a few words on the combination of remedies. The Faculty, and others, are always crying out for the trials of the airs *alone*, and forget that in their own practice they employ a variety of means. Thus, although exerciſe is recommended, is the ſtomach neglected to be braced and ſtimulated?

The following caſe from John Hunter* is very illuſtrative of this poſition:

"A lady, of what is called a nervous conſtitution, ariſing in ſome degree from an irritable ſtomach, often troubled with flatulencies, and what are called nervous head-achs, with pale urine at thoſe times, uncomfortable feelings and often ſinkings, had a tumor removed from the breaſt, and likewiſe near the arm-pit: nothing appeared uncommon for a few

* Vide *Hunter on the Blood*, p. 412.

days, when very conſiderable diſorders came on. She was attacked with a ſhivering, or cold fit, attended with the feel of dying, and followed with cold ſweats. It being ſuppoſed ſhe was dying, brandy was thrown in, which ſoon brought on a warmth, and ſhe was relieved. The fits came on frequently for ſeveral days, which were alſo relieved by brandy; and ſhe took, in one of the moſt violent, half a pint of brandy. While under theſe affections, ſhe had the bark as a ſtrengthener; the muſk occaſionally, as a ſedative, in pretty large quantities; camphorated jalap frequently, as an anti-ſpaſmodic; and, towards the laſt, ſhe took the valerian in large quantities: but whatever effects theſe might have in leſſening the diſeaſe, on the whole *they were certainly not equal to it without the brandy.*"

John Hunter judiciouſly adds: "A queſtion naturally occurs: Would *the brandy alone,* if it had been continued as a medicine, have cured her without the aid of the other medicines? The other medicines, I think, certainly could not have done it; nor do I believe that the brandy could have been continued in ſuch quantity as to have prevented their returns: if ſo, then *the two modes were happily united,* the one gradually to prevent, the other to remove immediately the fits when they came on."

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

AMERICAN PHILOSOPHICAL SOCIETY.

THIS Society has recently publiſhed the following circular letter:

"The American Philoſophical Society have always conſidered

ſidered the antiquity, changes, and the preſent ſtate of their own country as primary objects of their reſearch; and, with a view to facilitate ſuch diſcoveries, a permanent committee has been eſtabliſhed, among whoſe duties the following have been recommended as requiring particular attention:

"1. To procure one or more entire ſkeletons of the Mammoth, ſo called, and of ſuch other unknown animals as either have been, or hereafter may be diſcovered in America.

"2. To obtain accurate plans, drawings, and deſcriptions of whatever is intereſting (where the originals cannot be had); and eſpecially of ancient fortifications, tumuli, and other Indian works of art: aſcertaining the materials compoſing them, their contents, the purpoſes for which they were probably deſigned, &c.

"3. To invite reſearches into the natural hiſtory of the earth, the changes it has undergone as to mountains, lakes, rivers, prairies, &c.

"4. To inquire into the cuſtoms, manners, languages, and character of the Indian nations ancient and modern, and their migrations.

"The importance of theſe objects will be acknowledged by every lover of ſcience, and, we truſt, ſufficiently apologiſe for thus troubling you; for without the aid of gentlemen who have taſte and opportunity for ſuch reſearches, our means would be very confined. We therefore ſolicit your communications, now or in future, on theſe ſubjects; which will be at all times thankfully received, and duly noticed in the publications of the Society.

"As to the firſt object, the committee ſuggeſt, to gentlemen who may be in the way of inquiries of that kind, that the Great Bone Lick on the Ohio, and other places where there may be mineral ſalt, are the moſt eligible ſpots for the purpoſe, becauſe animals are known to reſort to ſuch places.

"With reſpect to the ſecond head, the committee are deſirous that cuts in various directions may be made into many of the tumuli, to aſcertain their contents, while the diameter

of

of the largeſt tree growing thereon, the number of its annulars, and the ſpecies of the tree, may tend to give ſome idea of their antiquity. If the works ſhould be found to be of maſonry; the length, breadth, and height of the walls ought to be carefully meaſured, the form and nature of the ſtones deſcribed, and ſpecimens of both the cement and ſtones ſent to the committee.

"The beſt methods of obtaining information on the other ſubjects will naturally ſuggeſt themſelves to you, and we rely on a diſpoſition favourable to our wiſhes.

"The Committee conſiſt of the following gentlemen, *viz.*

Thomas Jefferſon, Preſident of the American Philoſophical Society, at Monticello in Virginia.

James Wilkinſon, Commander of the Army, at Head Quarters.

George Turner, of the Weſtern Territory, near Cincinnati.

Dr. Caſpar Wiſtar, Vice-Pref. of the A. P. S.
Dr. Adam Seybert, Secretary of ditto.
C. W. Peale, and
Jon. Williams,
} in Philadelphia.

"Your communications may be addreſſed to any one of the Committee; but the articles you may think proper to furniſh, ſhould be ſent to this place.

In behalf of the Committee, I am, reſpectfully,
Sir, your obedient ſervant,
J. Williams, Chairman."

At the meeting of this Society, January 10, 1799, among other donations and communications, the following were announced as having been received:

A communication from Mr. Andrew Ellicot, determining the latitude and longitude of the town of Natchez—A letter from Dr. Prieſtley on the decompoſition of water—Three barrels, containing the bones of non-deſcript animals, and two meteorological journals kept at Detroit and on a voyage to Michilimacanac on the Lakes, by Gen. Wilkinſon—A ſpecimen of mica from New Hampſhire—Experiments and

obſervations on the atmoſphere and marſhes, by Dr. Seybert—And a paper concerning the pernicious effects of the *Equizetum hyemale*, or rough horſe-tail, when eaten by horſes; by Mr. Barton.

MISCELLANEOUS.

AMERICAN ENTOMOLOGY.

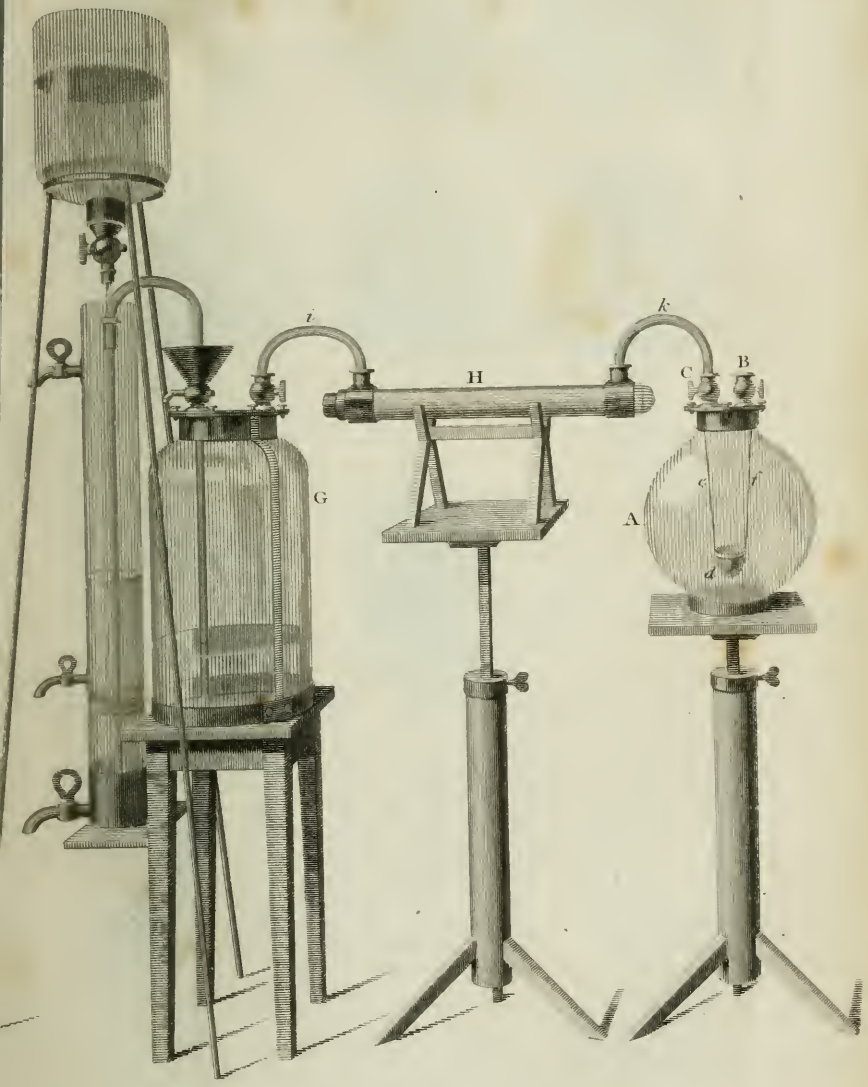
With pleaſure we announce to naturaliſts Mr. Baker's collection of American inſects. In his muſeum at New-York may be ſeen about three thouſand ſpecies, principally arranged according to the Linnæan ſyſtem. They were collected chiefly by Mr. Jotham Fenton, who has been nearly ſix years engaged in entomological purſuits. The ſpecies of this collection were moſtly caught in the neighbourhood of the cities of New-York and New-Haven.

FIRE-BALL.

A very remarkable phenomenon of this kind was ſeen in the county of Kent, and the neighbourhood, on Sunday the 22d September, at about 35 minutes paſt eight in the evening. It came from the ſouth-weſt, and paſſed in a ſouth-eaſt direction till it ſunk in the horizon. It ſeemed to be nearly of the ſize of the moon, but of an oval form, or rather in the form of an ox's bladder, the thickeſt end going foremoſt. The ſky, which was dark and ſtormy, was illuminated during its paſſage more brightly than by the full moon. Its colour was a vivid white, inclining a little to yellow; and it ſeemed as if followed by a few ſmaller globules, or rather large ſparks of a red colour, which kept at the ſame diſtance from its body during the whole time that it was viſible, which was for ſeveral ſeconds.

ASTRONOMY.

A comet is now viſible in our hemiſphere. It was firſt ſeen on the 6th inſt. near the lower ſide of the quadrangle of *Urſa Major*, from which it has been moving about 3° in 24 hours, following the direction of the tail, and through one ſhoulder of Bootes.



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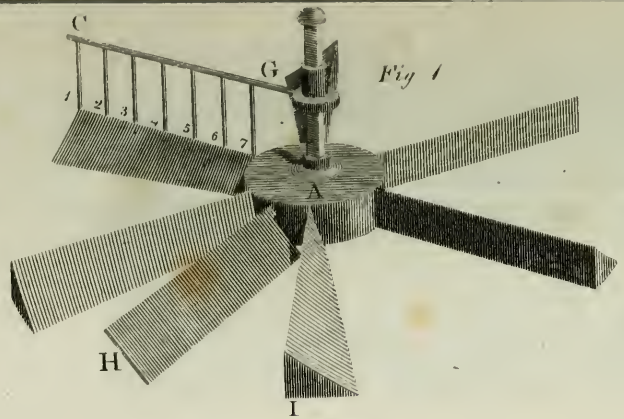

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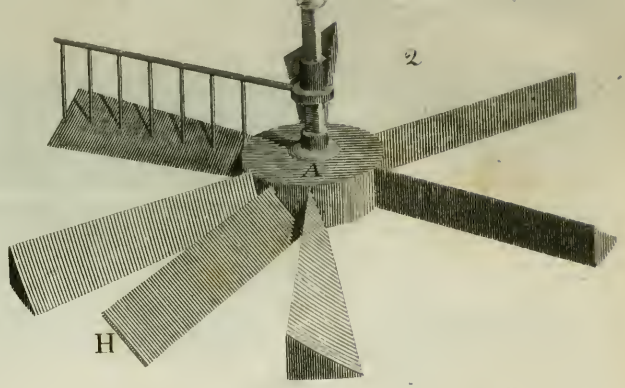

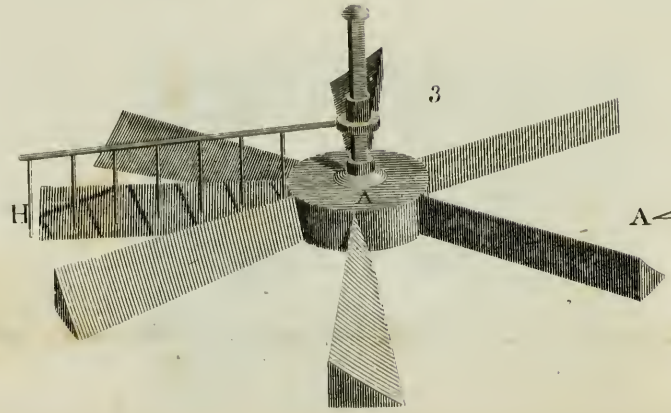

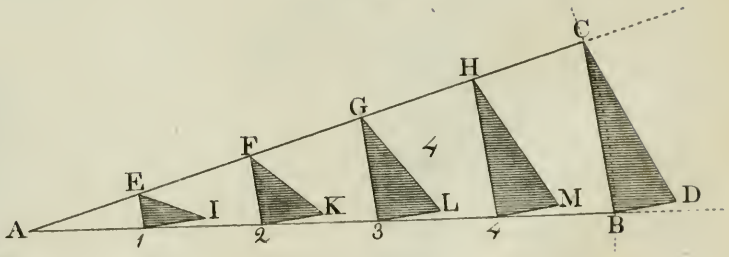

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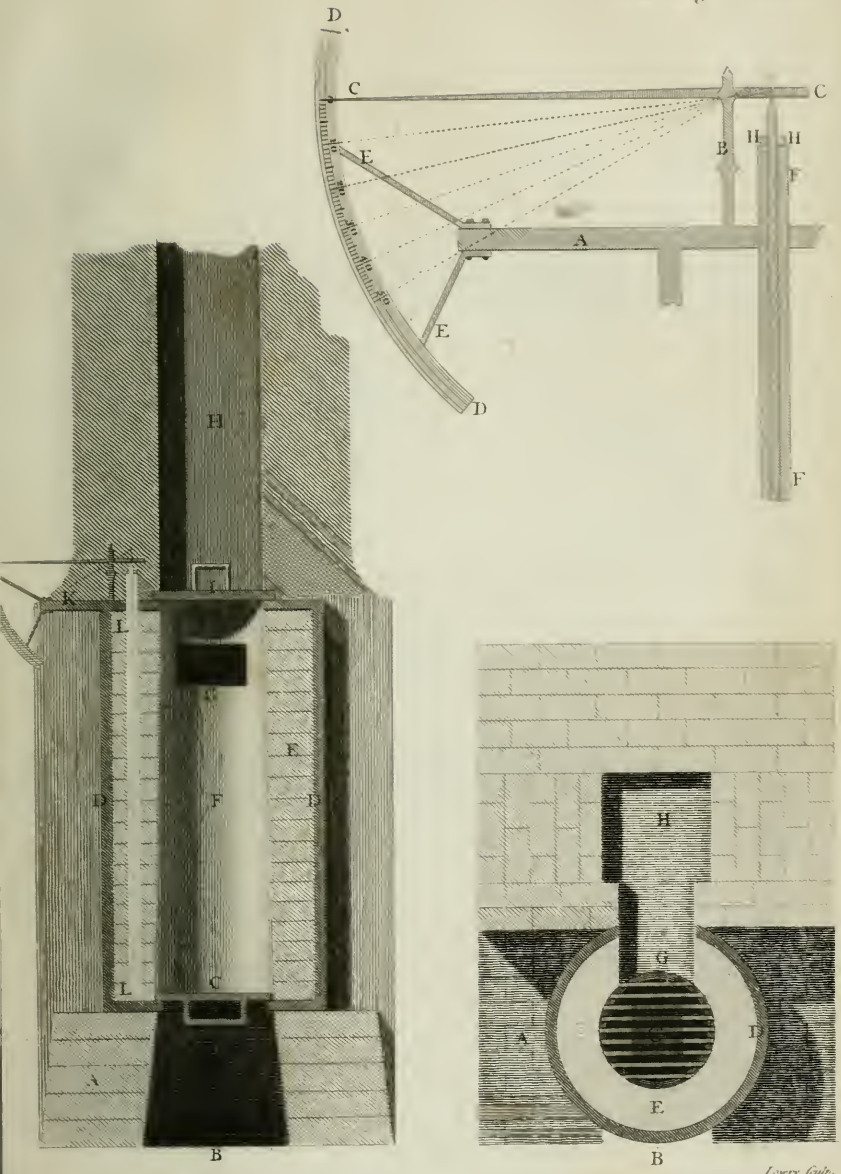

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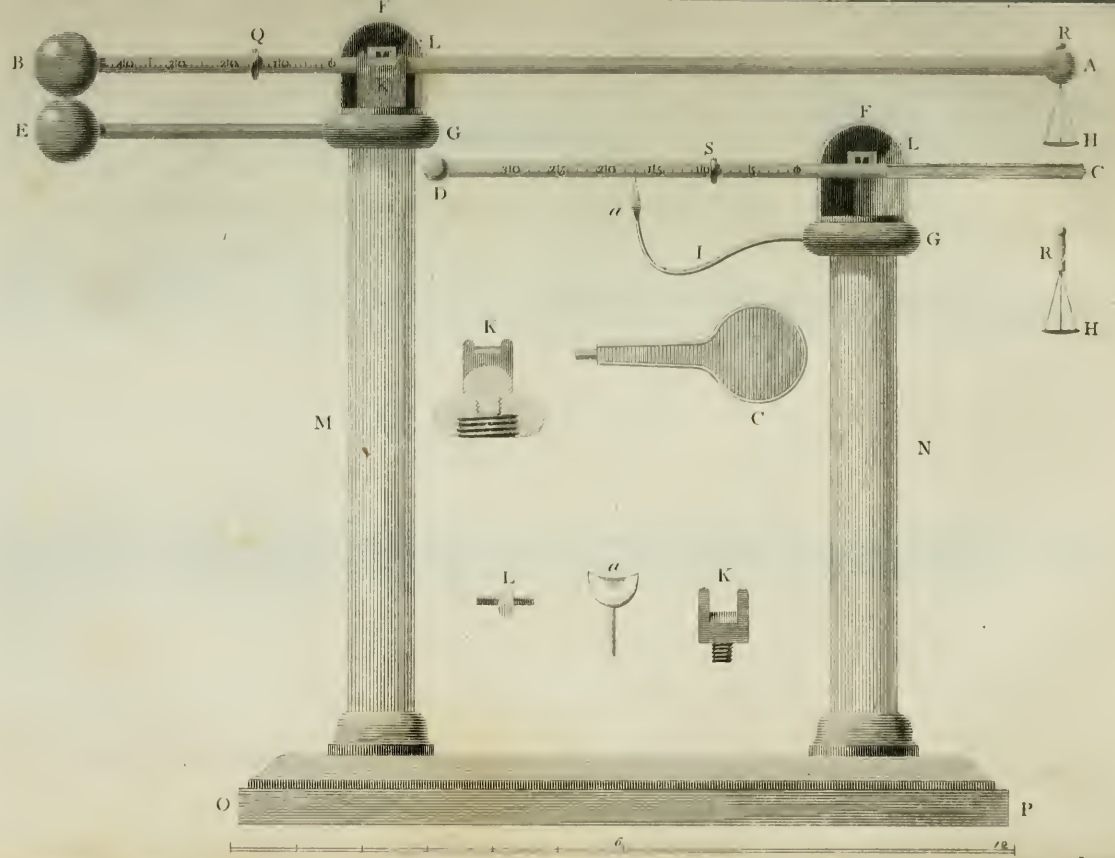
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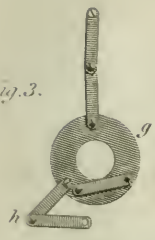

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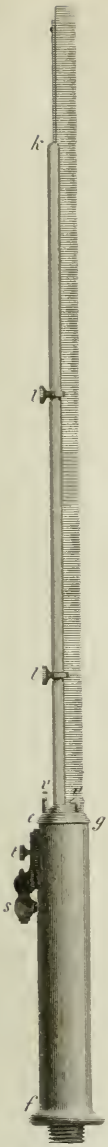

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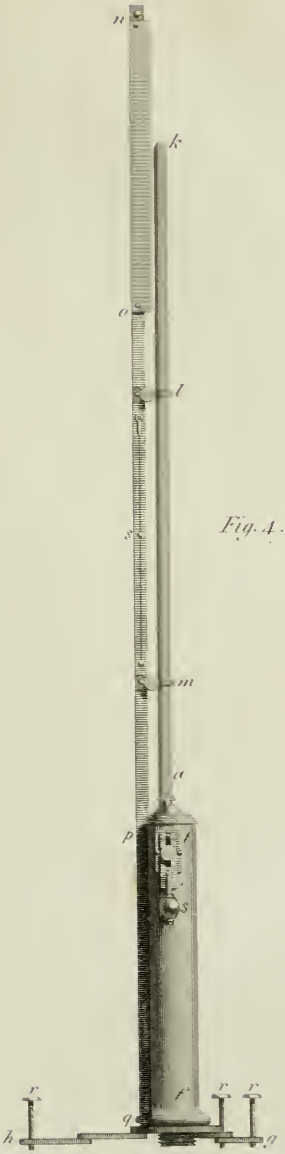

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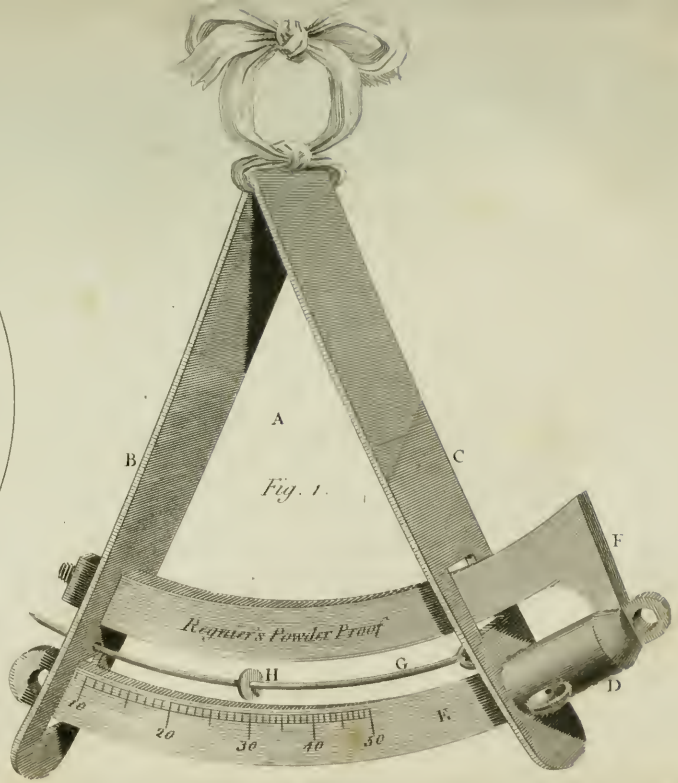

Fig. 1.

Lowry, sculp.

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END OF THE FOURTH VOLUME.

LONDON:

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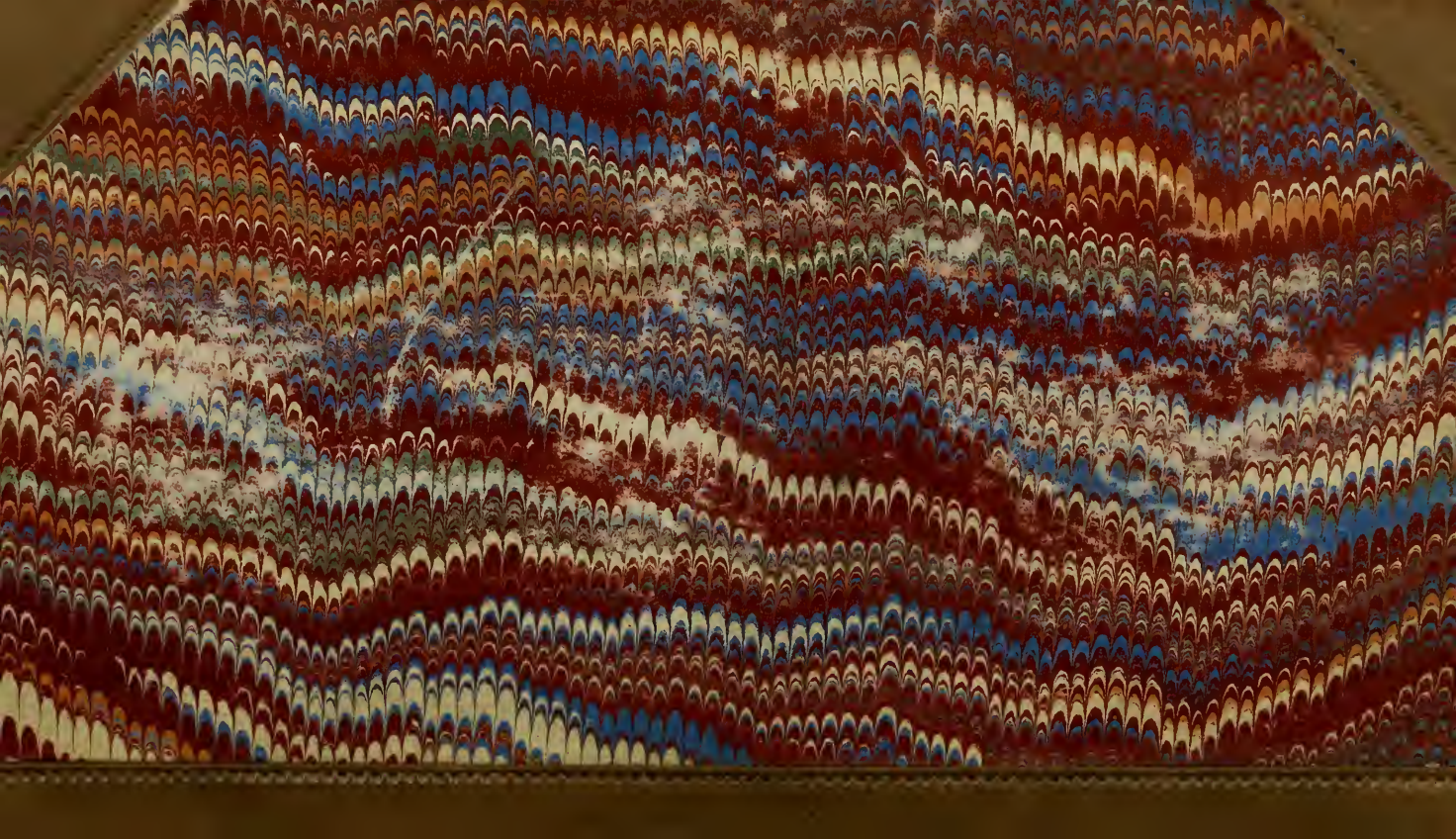
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